1. Which of the following are the advantages of silicon over Insulator (SOI)?

1. Lower diffusion capacitance

2. Smaller parasitic delay and lower dynamic power consumption

3. Lower threshold voltages

Select the correct answer using the code given below.

(A) 1, 2 and 3

(B) 1 and 2 only

(C) 1 and 3 only

(D) 2 and 3 only

Key: (A)

SOI reduces junction capacitance and improves power.

SOI advantages in General

1. Capacitance reduction: SOI devices have low drain to substrate capacitances, due to buried oxygen region. The reduction in source drain capacitance usually provides incremental speed improve-ment (or) conversely power reduction
2. Reduction short channel effect
3. Lower (V_t) device threshold
4. Soft error rate reduced in memory
5. Improves performances.

2. The finite state machine in which

1. The output is a function of the current state and inputs

2. The output is a function only the current state.

Which of the following machines are respectively correct for these styles?

(A) Mealy machine and Moore machin e

(B) Moore machine and Mealy machine

(C) State machine and Mealy machine

(D) State machine and State machine

Key:(A)

In mealy machine, the output is a function of present input and present state of the memory elements.

But in Moore machine the output is a function of present state of the memory elements only

3. In EPROMs, applying a high voltage to the upper gate causes electrons to jump through the thin oxide onto the floating gate through the process known as

(A) mask programming

(B) One – time programming

(C) avalanche injection or Fowler Nordheim tunnelling

(D) erasing

Key:(C)

In EEPROM, applying a high voltages to the upper gate causes electrons to Jump through the thin oxide on to the floating gate through the processes called

Avalanche injection (or) Fowler –Nordheim tunneling.

Injection the electrons induces a negative voltages on floating gate, effectively increases the threshold voltages of the transfer.

4. What is the range of values of a and b for which the linear time invariant system with impulse response $h(n)=\begin{cases} a^n, & n \ge 0 \\ b^n, & n<0 \end{cases}$ is stable?

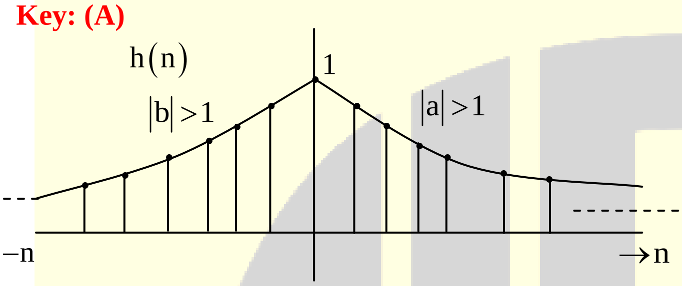
(A) Both |a| < 1 and |b|>1 are satisfied

(B) Both |a| > 1 and |b| < 1 are satisfied

(C) Both |a| > 1 and |b| > 1 are satisfied

(D) Both |a| < 1 and |b| < 1 are satisfied

Key: (A)



5. The special case of a finite duration sequence is given as

$$x(n)=\{2,\underset{\uparrow}{4},0,3\}$$

The sequence x(n) into a sum of weighted impulse sequences will be

(A) $2\delta(n+1)+4\delta(n)+3\delta(n-2)$

(B) $2\delta(n)+4\delta(n-1)+3\delta(n-3)$

(C) $2\delta(n)+4\delta(n-1)+3\delta(n-2)$

(D) $2\delta(n+1)+4\delta(n)+3\delta(n-1)$

Key: (A)

Given $x(n)=\left\{2,\underset{\uparrow}{4},0,5\right\}$

From above, at

$n=0,\ x(n)=4$, at $n=1\ x(n)=1$, at n=2, x(n)=?

So, it can be represented as

$$x(n)=2\delta(n+1)+4\delta(n)$$
$$+0\,\delta(n-1)+3\delta(n-2)$$
$$=2\delta(n+1)+4\delta(n)+3\delta(n-2)$$

6. The two advantages of FIR filters over IIR filters are

(A) they are guaranteed to be stable and non linear

(B) they are marginally stable and linear

(C) they are guaranteed to be stable and may be constrained to have linear phase

(D) they are marginally stable and non – linear

Key:(C)

7. The frequency response and the main lobe width for rectangular window are

(A) $\dfrac{\sin\frac{\omega N}{2}}{\sin\frac{\omega}{2}}$ and $\dfrac{4\pi}{N}$ (B) $\dfrac{\sin\frac{\omega N}{2}}{\frac{\omega}{2}}$ and $\dfrac{\pi}{N}$

(C) $\dfrac{\sin\frac{\omega}{2}}{\sin\frac{\omega N}{2}}$ and $\dfrac{2\pi}{N}$ (D) $\dfrac{\sin\frac{\omega N}{4}}{\sin\frac{\omega}{2}}$ and $\dfrac{8\pi}{N}$

Key:(A)

Type of window	Transition width of main lobe	Peak side lobe
1.Rectangular	$\frac{4\pi}{M}$	-13
2. Bartlett	$\frac{8\pi}{M}$	-25
3. Hanning	$8\pi/M$	-31
4. Hamming	$8\pi/M$	-41
5. Black man	$12\pi/M$	-57

8. A controller that takes control of the buses and transfers data directly between source and destination bypassing the microprocessor is known as

(A) DMA controller

(B) read – write controller

(C) high speed controller

(D) master slave controller

Key:(A)

Direct memory Access (DMA) controller is used to store the data or read the data in the memory without the intervention of microprocessor.

9. A 2-byte instruction which accepts the data from the input port specified in the second byte and loads into the accumulator is

(A) OUT < 8-bit port address>

(B) IN < 8-bit port address>

(C) OUT R < 8-bit port address>

(D) IN R < 8-bit port address>

Key:(B)

IN <8 bit port address > is an instruction used in 8085 microprocessor to read the data form input ports.

10. Consider the following instruction:

EI

MVI A, 08H

SIM

It means

(A) disable all interrupts

(B) enable all interrupts

(C) disable RST 7.5 and 6.5

(D) enable RST 7.5 and 6.5

Key:(B)

SIM instruction

D_7	D_6	D_5	D_4	D_3	D_2	D_1	D_0
SOD	SDE	X	R7.5	MSE	M7.5	M6.5	M5.5
0	0	0	0	1	0	0	0

MVI A, 08 H ; A : 0000 1000 H

Here MSE: Mask set Enable = 1, mask is set

$$D_2, D_1, D_0 \rightarrow \left.\begin{matrix} \text{RST 5.5} \\ \text{RST 6.5} \\ \text{RST 7.5} \end{matrix}\right\} \begin{matrix} 0 = \text{Available} \\ 1 = \text{Masked} \end{matrix}$$

11. The instruction BC 0×15 means

(A) jump 15 bytes relative to the program counter

(B) copy and load 15 words in reverse direction to the program counter

(C) move to a location by 15 bits to the program counter

(D) redirect (jump) to a location by 15 words relative to the program counter

Key:(D)

Branch instruction BC n

B C 0×15: Branch if carry +15 H words

The instruction BC refers to branch if carry.

12. Which of the following constraints are to be considered by the designer while designing an embedded system?

1. Selecting the microcontroller as a controlling device

2. Selecting the language to write the software

3. Partitioning the tasks between hardware and software to optimize the cost

Select the correct answer using the code given below.

(A) 1, 2 and 3

(B) 1 and 2 only

(C) 1 and 3 only

(D) 2 and 3 only

Key:(A)

13. Which one of the following is the correct combination for a layer providing a service by means of primitives in an open systems interconnection?

(A) Request, Indication, Response and Confirm

(B) Request, Inform, Response and Service

(C) Request, command, Response and Action

(D) Request, confirm, Indication and Action

Key:(A)

14. A network uses a fully interconnected mesh topology to connect 10 nodes together. The number of links required will be

(A) 35

(B) 40

(C) 45

(D) 50

Key:(C)

To create a mesh topology assuming n number of nodes we require $\frac{n(n-1)}{2}$ number of times

So, as per question, n = 10

$\Rightarrow \text{number of links} = \frac{10(10-1)}{2} = 45.$

Hence option 'C' correct

15. Which of the following are the advantages of packet switching?

1. Greater link efficiency than circuit switching

2. Connections are not blocked when traffic congestion occurs

3. Direct channel established between transmitter and receiver

4. No time is taken to establish connection

Select the correct answer using the code given below.

(A) 1 and 3

(B) 1 and 2

(C) 2 and 3

(D) 3 and 4

Key:(B)

As packet switching is connection less switching, we don't require connection establishment.

So, statement 3 & 4 are incorrect.

Statement 1 is TRUE

Greater quick efficiency than circuit switching because of effective resource utilization in packet switching

Statement 2 is TRUE

As packet switching is implemented at network layer of model. Congestion can be handled. So, connections are not blocked.

Hence, option B is correct.

16. A message consisting of 2400 bits is to be passed over an internet. The message is passed to the transport layer which appends a 150-bit header, followed by the network layer which uses a 120- bit header. Network layer packets are transmitted via two networks, each of which uses a 26-bit header. The destination network only accepts up to 900 bits long. The number of bits, including headers delivered to the destination network, is

(A) 2706 bits

(B) 2634 bits

(C) 2554 bits

(D) 2476 bits

Key:(A)

Message size = 2400 bits.

Segment size at transport layer =

$2400+150=2550$ bits

Maximum, transmission unit at destination network = 900 bits

So, At a time, data that can be passed through destination network is

$900-\underset{(HL)}{26}=874$ bits

So $\rightarrow$ Length of packet 1 = 874 (data)

Length of packet 2 = 874 (data)

Length of packet 3 = 802 (data)

The number of bits, including headers delivered the destination n/w is

Packet 1 (Delta + Header) size = 26+26+874

Packet 2 (Delta + Header) size = 26+26+874

Packet 3 (Delta + Header) size = 26+26+802

$\Rightarrow$ 2706 bits.

Hence option A is correct.

17. In a communication network, 4T1 streams are multiplexed to from 1 T2 stream and 7 T1 streams are multiplexed to form 1 T3 stream. Further 6 T3 streams are multiplexed to form 1 T4 stream. If each T1 stream is of 1.544 Mbps, the data rate of 1 T4 stream should be

(A) 211.8 Mbps

(B) 232.6Mbps

(C) 243.4Mbps

(D) 274.2Mbps

Key:(D)

The M 23 multiplexer adds nominally 69 bits for synchronization and pulse stuffing; hence the number of bits per frame for a T3 line is

$789\times7+69=5592$ bits/frame

and $f_b(T3)=5592\times8000=44.736$ Mb/s

The M34 multiplexer adds nominally 720 bits for synchronization and pulse stuffing and therefore the T4 system has a bit rate

$f_b(T4)=274.176$ Mbps

18. Which of the following statements are correct regarding CDMA?

1. It is similar to GSM.

2. It allows each station to transmit over the entire frequency spectrum all the time.

3. It assumes that multiple signals add linearly.

Select the correct answer using the code given below.

(A) 1 and 2 only

(B) 1 and 3 only

(C) 2 and 3 only

(D) 1, 2 and 3

Key:(D)

19. Which of the following regarding regular systems with small cells are correct?

1. Higher capacity and robustness

2. Needless transmission power and have to deal with local interference only

3. Frequency planning and infrastructure needed

4. These require both circuit switching and packet switching

Select the correct answer using the code given below.

(A) 1, 2 and 4

(B) 1, 3 and 4

(C) 1, 2 and 3

(D) 2, 3 and 4

Key:(C)

Advantages of cellular system with small cells.

1. High Capacity
2. Less transmission power
3. Local Interference only
4. Robustness

Disadvantages:

1. Infrastructure needed
2. Handover need
3. Frequency planning: to avoid interference between transmitters using some frequencies, Frequencies distributed carefully

20. A satellite is orbiting in the equatorial plane with a period from perigee to perigee of 12 h. If the eccentricity = 0.002, i =0°, K_1 = 66063.17km^2, $\mu = 3.99\times10^{14} m^3/s^2$ and the earth's equatorial radius = 6378.14km, the semi-major axis will be

(A) 34232km

(B) 30424km

(C) 26612 km

(D) 22804km

Key:(C)

$$n = \frac{2\pi}{p} = 1.454\times10^{-4}\, s^{-1}$$

$$a = \left(\frac{\mu}{n^2}\right)^{1/3} = 26610 \text{ km}$$

Solving the square loot equation yields vole of 26,612 km

21. A single – mode optical fiber has a beat length of 8 cm at 1300nm. The value of birefringence B_f will be nearly

(A) 1.6×10^{-5}

(B) 2.7×10^{-5}

(C) 3.2×10^{-5}

(D) 4.9×10^{-5}

Key:(A)

$$B_f = \frac{\ell}{L_p} = \frac{1300\text{ nm}}{8\text{cm}} = 1.6\times10^{-5}$$

22. Which one of the following instruments is useful while measuring the optical power as a function of wavelength?

(A) Optical power attenuator

(B) Optical power meter

(C) Optical spectrum analyzer

(D) Optical return loss tester

Key:(B)

The function of optical power meter is to measure total power over a selected wavelength Band

23. The optical performance monitoring involves

(A) transport layer monitoring, optical signal monitoring and protocol performance monitoring

(B) physical layer, network layer and application layer monitoring

(C) data – link layer, presentation layer and session layer monitoring

(D) transport layer, session layer and application layer monitoring

Key:(A)

24. An earth station at sea level communicates at an elevation angle of 35° with GEO satellite. The vertical height of the stratiform rain is 3km. The physical path length L through the rain will be nearly

(A) 6.3km

(B) 5.2km

(C) 4.1km

(D) 3.0km

Key:(B)

$$L = \frac{H_e - H_o}{\sin(EL)}$$

Where EL = Elevation angle

H_e = effective rain height

H_o = Height of the earth station of above sea' Level

$$L = \frac{3km}{\sin 30} = 5.2km.$$

Where EL= Elevation angle

He = Effective rain height

Ho = Hieght of the earth station of above sea level

$$L = \frac{3\,km}{\sin 30} = 5.2\,km.$$

Directions:

*The following **six (6)** items consist of two statements, one labelled as 'Statement (I)' and the other as 'Statement (II)'. You are to examine these two statements carefully and select the answers to these items using the code given below:*

Codes:

(A) Both Statement (I) and Statement (II) are individually true and Statement (II) is the correct explanation of Statement (I)

(B) Both Statement (I) and Statement (II) are individually true but Statement (II) is not the correct explanation of Statement (I)

(C) Statement (I) is true but Statement (II) is false

(D) Statement (I) is false but Statement (II) is true.

25. **Statement (I):** Sign magnitude representation is rarely used in implementing the integer portion of the ALU.

Statement (II): There are two representations of zero in sign magnitude representation.

Key:(A)

In modern computer system 2's complement representation is used. In sign and magnitude representation 0 is having two representations.

Consider 4 bit sign and magnitude representation:

0000 is (+0)

1000 is considered as (-0)

26. **Statement (I):** Dynamic loading gives better memory space utilization.

Statement (II): In dynamic loading, and unused routine is never loaded.

Key:(A)

In dynamic loading when module is needed then only it's loaded into memory. This will help us to better utilization of the memory because unused routine will never get allocation.

27. **Statement (I):** SRAM is used for cache memory and DRAM is used for main memory.

Statement (II): SRAM is somewhat faster than DRAM.

Key:(A)

SRAM is made up of flipflops and DRAM is made up of MOS capacitors that needs to be refreshed periodically by a separate circuit Inherently SRAM is faster than DRAM and hence SRAM is used in CACHE memory. But DRAM is cheaper to be used in main memory.

28. **Statement (I):** In a multiuser system, each user is assigned a section of usable memory area and is not allowed to go out of the assigned memory area.

Statement (II): In a multiuser system, there is a software mechanism to prevent unauthorized access of memory by different users.

Key:(A)

In a multiuser system, each user is assigned a section of usable memory area and is not allowed to access any other part of the memory. Its generate hardware trap if memory bound is violated.

29. **Statement (I):** The external surface of a crystal is an imperfection in itself as the atomic bonds do not extend beyond the surface.

Statement (II): The external surfaces have surface energies that are related to the number of bonds broken at the surface.

Key:(B)

30. **Statement (I):** By organizing various 'optical functions' into an 'array structure' via nano- pattern replication 'spatial integration' is established.

Statement (II): By adding a nano – optic layer or layers to functional optical materials, the 'hybrid integration' is possible to be achieved.

Key:(B)

31. Consider a common emitter current gain of $\beta = 150$ and a base current of $i_B = 15\,\mu A$. If the transistor is biased in the forward active mode, the collector and emitter current will be

(A) 2.25mA and 2.27mA

(B) 3.25 mA and 2.27mA

(C) 2.25 mA and 1.37 mA

(D) 3.25 mA and 1.37 mA

Key:(A)

Transistors collector current at forward active region is

$$I_c \approx \beta I_B = 150\times 15\times 10^{-3}$$
$$= 2.25\text{ mA}$$
$$I_E = I_C + I_B$$
$$= 2.265\text{ mA}$$

32. The input to a bridge rectifier is 230V (r.m.s), 50Hz. The d.c. output voltage and the ripple factor with R_L of 100Ω and capacitor filter of $1000\,\mu F$ are

(A) 207V and 0.028

(B) 325 V and 0.028

(C) 207 V and 0.020

(D) 325 V and 0.020

Key:(B)

For a full wave rectifier

$$V_{dc} = \frac{2V_m}{\pi}$$

$$\text{given } V_{rms} = \frac{V_m}{\sqrt{2}} = 230$$

$$V_m = 325.27 \text{ volt}, V_{dc} = 207$$

$$V_R = \frac{1}{2}\frac{V_m - 2V_D}{R_L Cf} = \frac{1}{2}\frac{325-(2\times0.7)}{100\times1000\times10^{-6}\times50}$$

$$= 32.36 \text{ volt.}$$

33. The effect of reduction in effective base width due to increase in reverse voltage of BJT is

(A) Hall effect

(B) Early effect

(C) Zener effect

(D) Miller effect

Key:(B)

The reduction in base width of the BJT due to reverse biased collector base junction is known as early effect.

34. What is is the drain current for a D-MOSFET having the characteristic values I_{DSS} of 10mA, $V_{GS(off)}$ of – 4 v and V_{GS} of + 2V?

(A) 22.5mA

(B) 17.5mA

(C) 12.5mA

(D) 2.5mA

Key:(A)

For depletion MOSFET, the drain current in saturation region is given as

$$I_D = I_{DSS}\left[1-\frac{V_{GS}}{V_p}\right]^2$$

$$= 10\left[1-\frac{2}{(-4)}\right]^2 = 22.5\text{mA}$$

35. In the Wien bridge oscillator, the 0° phase shift is met by using lead lag network and by using

(A) inverting op-amp

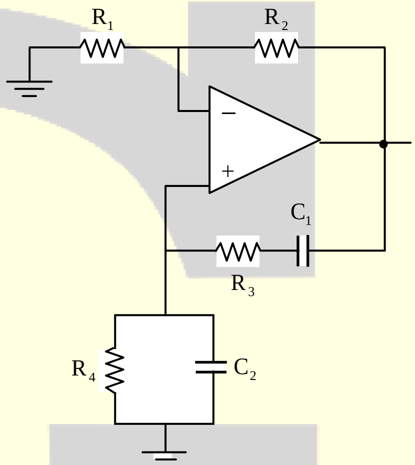
(B) non inverting op-amp

(C) feedback op-amp

(D) high – gain op – amp

Key:(B)

Wien bridge oscillator



36. What is the frequency of oscillation for an RC phase shift oscillator with R of $10\,k\Omega$ and C of $0.001\,\mu F$ in each of its three RC sections?

(A) 5.0kHz

(B) 5.5kHz

(C) 6.0kHz

(D) 6.5kHz

Key:(D)

From an RC phase shift oscillator the frequency of oscillation is

$$f = \frac{1}{2\pi\sqrt{6}RC}$$

$$= \frac{1}{2\pi\sqrt{6}\times10\times10^3\times0.001\times10^{-6}} = 6.497 \text{ kHz}$$

37. When there is no clock signal applied to CMOS logic circuits, they are referred to as

(A) complex CMOS logic circuits

(B) static CMOS logic circuits

(C) NMOS transmission gates

(D) random PMOS logic circuits

Key:(B)

CMOS circuits functioning without clock are called a $\rightarrow$ static CMOS logic circuit

38. One form of NMOS circuit logic that minimizes power dissipation and maximizes device density is called

(A) pass transistor logic

(B) sequential logic circuit

(C) NMOS SRAM cell

(D) NMOS transmission gate

Key:(A)

Pass transistor logic circuits are mode of NMOS transistors that minimizes power dissipation.

39. The ideal op-amp has

(A) infinite voltage gain and zero input impedance

(B) Infinite voltage gain and infinite bandwidth

(C) zero voltage gain and infinite CMRR

(D) Zero output impedance and zero CMRR

Key:(B)

Infinite voltage going and infinite bond width are characteristics of the ideal op-amp

40. A d.c. voltage supply provides 60V when the output is unloaded. When connected to a load, the output drops to 56V. The value of the voltage regulation is

(A) 3.7%

(B) 5.7%

(C) 7.1%

(D) 9.1%

Key:(C)

Voltage Regulation

$$= \frac{V_{\text{No Load}} - V_{\text{Full load}}}{V_{\text{Full load}}} \times 100\%$$

$$= \frac{60-56}{56} \times 100 = 7.1\%$$

41. In optical communication, the maximum angle in which external light rays may strike the air/glass interface and still propagate down the fiber is called as

(A) critical angle

(B) numerical aperture

(C) angle of refraction

(D) acceptance angle

Key:(D)

Acceptance angle θ_a is the maximum angle made by the right ray with the fiber axis, so that the light can propagate inside the fiber.

The relation between numerical aperture NA and acceptance angle θ_a is $NA = \sin\theta_a$

42. The light intensity 3m from a lamp that emits 25W of light energy will be

(A) 243 mW/m^2

(B) 232mW/m^2

(C) 221mW/m^2

(D) 210mW/m^2

Key:(C)

Assuming that the lamp is a point source that emits light waves in all the directions.

The intensity at r distance from the light source is

$$=\frac{\text{Power emitted}}{4\pi r^2}$$

$$=\frac{25}{4\pi\times 3^2}=0.221\,w/m^2=221\,mw/m^2$$

43. Two resistances, one of $30\,\Omega$ and another of unknown value, are connected in parallel. The total power dissipated in the circuit is 450W when the applied voltage is 90V. The unknown resistance is

(A) $45\,\Omega$

(B) $35\,\Omega$

(C) $30\,\Omega$

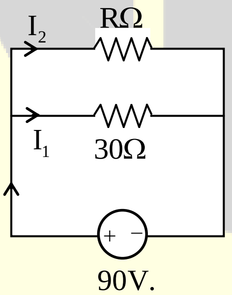
(D) $20\,\Omega$

Key:(A)

Current through $30\,\Omega$

$$I_1=\frac{V}{R_{30}}$$

$$=\frac{90}{30}=3A$$



Current through unknown resistance R

$$I_2=\frac{90}{R}A$$

In a parallel circuit

Total current, $I=I_1+I_2=\left(3+\frac{90}{R}\right)A$

Total power delivered by a voltage source = total power dissipated in the circuit

$$90\times I=450$$

$$450=90\times\left(30+\frac{90}{R}\right)$$

$$R=45\Omega$$

44. An electric kettle contains 1.5kg of water at 15^0C.It takes15 minutes to raise the temperature of water to 95°C. If the heat loss due to radiations and heating the kettle is 15 k calories and the supply voltage is 100V, the current taken will be

(A) 8.0A

(B) 7.1A

(C) 6.3A

(D) 5.4A

Key:(C)

Energy produced by electric kettle

= energy consumed + heat loss.

$=ms\theta$ + heat loss

$$=\left[\left(1.5\times10^3\right)\times1\times\left(95-15\right)\right]+\left(15\times10^3\right)$$

$$=135\times10^3\text{ cal}$$

Converting to joule

$$=135\times4.2\times10^3\text{ Joule}$$

Energy Produced by kettle = V.I. t

$$V.I.t=135\times4.2\times10^3$$

$$I=\frac{135\times4.2\times10^3}{100\times\left(15\times60\right)}$$

$$I=6.3A$$

45. A heater element is made of nichrome wire having resistivity equal to $100\times10^{-8}\,\Omega\,m$ and diameter of 0.4mm. The length of the wire required to get a resistance of $40\,\Omega$ will be nearly

(A) 9m

(B) 7m

(C) 5m

(D) 3m

Key:(C)

$$\rho = 600\times10^{-8}\,\Omega - m$$

$$D = 0.4\times10^{-3}\,m$$

$$R = \frac{\rho\ell}{A}$$

$$A = \frac{\pi}{4}D^2$$

$$40 = \frac{100\times10^{-8}\times\ell}{\frac{\pi}{4}\times\left(0.4\times10^{-3}\right)^2}$$

$$\ell = 5.02\ m$$

46. A car is travelling at 72km/h. If the length of an axle is 2 m and the vertical component of the earth's magnetic field is $40\,\mu\,Wb/m^2$, the e.m.f. generated in the axle of the car is

(A) 2.6mV

(B) 2.2mV

(C) 1.6mV

(D) 1.2mV

Key:(C)

$$V = 72\,km/h$$

Converting km/h in to m/s

$$\Rightarrow \frac{72\times10^3}{60\times60} = 20\ m/s$$

$$\text{E.M.F generated} = e = B\,\ell\,V\sin\theta$$

$$\text{As}\ \ \theta = 90°\left[\text{vertical component}\right]$$

$$e = 40\times10^{-6}\times2\times20$$

$$\therefore e = 1.6mV$$

47. In a telephone receiver, the size of each of the two poles is 1.2cm×0.2cm and the flux between each pole and the diaphragm is 3×10^{-6} Wb. The force attracted to the poles will be nearly

(A) 0.15N

(B) 0.20N

(C) 0.30N

(D) 0.40N

Key:(A)

$$\text{Force,}\ \ F = \frac{B^2A}{2\mu_0} - (1)$$

$$\text{But } B = \frac{\phi}{A} \quad -(2)$$

Substituting (2) is (1), we get

$$F = \frac{\frac{\phi^2}{A^2}A}{2\,\mu_0} = \frac{\phi^2}{2A\,\mu_0}$$

$$= \frac{\left(3\times10^{-6}\right)^2}{2\times1.2\times0.2\times10^{-4}\times411\times10^{-7}}$$

$$F = 0.15N$$

48. An inductor of 0.5H inductance and $90\,\Omega$ resistance is connected in parallel with a $20\,\mu$F capacitor. A voltage of 230V at 50Hz is maintained across the circuit. The total power taken from the source is nearly

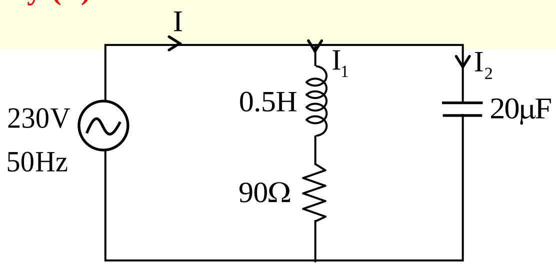
(A) 588W

(B) 145W

(C) 135W

(D) 125W

Key:(B)



As it is parallel network, total power taken from source is sum of power taken by each branch.

Power taken form source $= I_1^2 R_1$

$$P = \left[\frac{V}{|Z_1|}\right] R_1$$

$Z_1 = R_1 + jX_L$

$Z_1 = 90 + j0.5 \times 2\pi \times 50$

$Z_1 = 90 + j50\,\pi$

$$P = \frac{(2.30)^2}{90^2 + 2500\pi^2} \times 90 = 145.26W$$

49. A 240V shunt motor with the armature resistance of 0.1 Ω runs at 850 rpm. for an armature current of 70A. If its speed is to be reduced to 650rpm., the resistance to be placed in series for an armature current of 50A is nearly.

(A) 0.82 Ω

(B) 1.14 Ω

(C) 1.24 Ω

(D) 1.34 Ω

Key:(B)

$V_t = 240V, R_a = 0.1\Omega, N_1 = 850rpm, I_q = 70A.$

$N_2 = 650rpm, I_{a_2} = 50A, R_{ext} = ?$

For $N_1 = 850$ rpm & $I_{a_1} = 70A$.

$E_{a_1} = V_t - I_{a_1} R_a$

$= 240 - 70 \times 0.1$

$E_{a_1} = 233V$

For $N_2 = 650$ rpm, $I_{a_2} = 50A$

$E_a \propto \phi.\omega_m$

$E_a \propto N\,(\phi - \text{constant})$

$$\frac{E_{a_2}}{E_{a_1}} = \frac{N_2}{N_1}$$

$$E_{a_2} = \frac{650}{850} \times 233 = 178.176V$$

When external resistance is added.

$E_{a_2} = V_t - I_{a_2}(R_a + R_{ext})$

$R_{ext} = 1.14\Omega$

50. A 200V d.c. shunt motor with armature resistance of 0.2 Ω and carrying a current of 50A is running at 960 r.p.m If the flux is reduced by 10% at constant torque and with negligible iron and friction losses, the speed will be nearly

(A) 1280r.p.m

(B) 1170r.p.m

(C) 1100r.p.m

(D) 1060r.p.m

Key:(D)

$V = 200V, R_a = 0.2\Omega, I_a = 50A, N = 960rpm$

$\phi_2 = 0.9\phi_1$

$E_{a_1} = V_t - I_{a_1} R_a$

$= 200 - 50 \times 0.2 = 190V$

Given Torque is constant

$T = k_a \phi . I_a$

$\phi_1 I_{a_1} = \phi_2 I_{a_2}$

$$I_{a_2} = \frac{\phi_1}{0.9\phi_1} I_{a_1}$$

$$I_{a_2} = \frac{50}{0.9} = 55.55A$$

$E_{a_2} = V_t - I_a R_a$

$= 200 - 55.55 \times 0.2 = 188.89V$

$E_a \propto \phi.N$

$$\frac{E_{a_2}}{E_{a_1}} = \frac{\phi_2 N_2}{\phi_1 N_1}$$

$$\frac{188.89}{190} = \frac{0.9\phi_1}{\phi_1} \times \frac{N_2}{960}$$

$N_2 = 1060.4$ rpm

51. Which of the following statements are **CORRECT** for d.c. shunt motor?

1. Speed of a shunt motor is sufficiently constant.

2. For the same current input, its starting torque is not as high as that of a series motor.

3. The motor can be directly coupled to a load such as a fan whose torque increases with speed.

Select the **CORRECT** answer using the code given below.

(A) 2 and 3 only

(B) 1 and 3 only

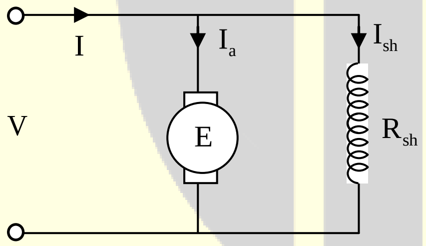
(C) 1 and 2 only

(D) 1, 2 and 3

Key:(C)

Statement –I is correct, as in a dc shunt motor.

$$I_{sh} = \frac{V}{R_{sh}}$$



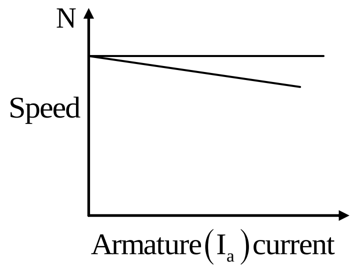
If, terminal voltage V is constant, then I_{sh} is also constant. Hence, the flux is also constant at no load. Due to armature reaction, when on load, the flux decreases slightly.

$\because$ Speed of the motor,

$$N \propto \frac{V - I_n R_a}{\phi}$$

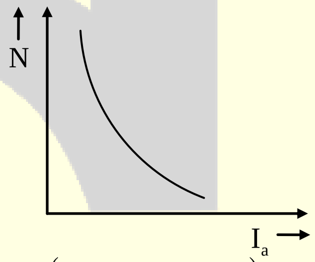
If, ϕ is constant and as $I_a R_a$ is a small drop (R_a being very small). Also, decrease in N due to $I_a R_a$ is partially compensated by reduction in ϕ due to armature reaction.

Hence, N is almost constant.



(DC shunt motor)

Statement-2 is also correct as for a dc series motor the starting torque is very high.



(DC series motor)

Statement-3 is incorrect for the above two figures as in case of fan load the DC motor torque does not increase with speed. (Rather DC series motor is used for this purpose)

52. Consider the following materials:

1. Lead peroxide

2. Sponge lead

3. Dilute sulphuric acid

Which of the above are active materials of a lead -acid battery?

(A) 1 and 2 only

(B) 1 and 3 only

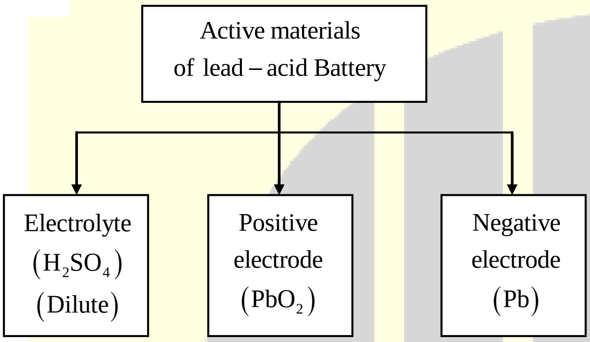
(C) 2 and 3 only

(D) 1, 2 and 3

Key:(D)

The active materials in a battery are those that participate in the electrochemical charge/discharge reaction. These materials include the electrolyte and positive/negative electrode.

In lead-acid battery, the electrolyte is a dilute solution of sulfuric acid (H_2SO_4). The negative electrode of a fully charged battery is composed of sponge lead (Pb) and the positive electrode is composed of lead dioxide (PbO_2)



53. Which of the following statements are **CORRECT** for a fully charged lead – acid cell?

1. Gassing occurs at both electrodes.

2. The terminal voltage is 2.6V

3. The specific gravity of the electrolyte is 1.21.

Select the **CORRECT** answer using the code given below.

(A) 1 and 2 only

(B) 1 and 3 only

(C) 2 and 3 only

(D) 1, 2 and 3

Key:(D)

Gassing - The charging reaction converts the lead sulphate at the negative electrode to lead. At the positive terminal the reaction converts the lead to lead oxide. The charging current electrolyzes the water from the electrolyte and both hydrogen and oxygen gas are evolved, this process is known as gassing.

It raises safety concerns due to explosive nature of hydrogen produced.

It causes shedding of active material causing permanent damage to the battery capacity.

Hence, statement-1 is true as gassing occurs at both the electrodes.

Also, statement-2 and statement-3 are correct as there are standard values for a fully charged lead-acid battery.

54. Which of the following statements are **CORRECT** for synchronous motors?

1. Synchronous motors are well – suited for direct connection to reciprocating compressors.

2. Over – excited synchronous motors are most commonly used for power factor improvement.

3. Synchronous motors are generally used for current regulation of long transmission lines.

Select the **CORRECT** answer using the code given below.

(A) 1, 2 and 3

(B) 1 and 3 only

(C) 1 and 2 only

(D) 2 and 3 only

Key:(C)

Synchronous motors are well suited for direct connection to reciprocating compressors due to highly variable load characteristic.

Hence, statement-1 is correct. Over-excited synchronous motors work as synchronous condenser as they draw leading current or improves the power factor of the system.

For an over-excited synchronous motor,

$|E|\cos\delta > |V|$

Where δ is the machine angle/torque angle.

Hence, statement-2 is correct.

Due to the above explanation, synchronous motors are also used for improving voltage regulation of long transmission line (not current regulation)

Hence, statement-3 is incorrect.

55. Which crystal system requires six lattice parameters to fully specify its unit cell?

(A) Triclinic

(B) Monoclinic

(C) Cubic

(D) Hexagonal

Key:(A)

Triclinic, also known as anorthic, is a crystal system with the lowest symmetry. In this system there are no restrictions on angles or sides.

$a \neq b \neq c$

$\alpha \neq \beta \neq \gamma$

Try changing the unit cell one parameter at a time for a, b, c, α, β and γ.

56. The minimum cation – to – anion radius ratio for the coordination number 3 is

(A) 0.175

(B) 0.155

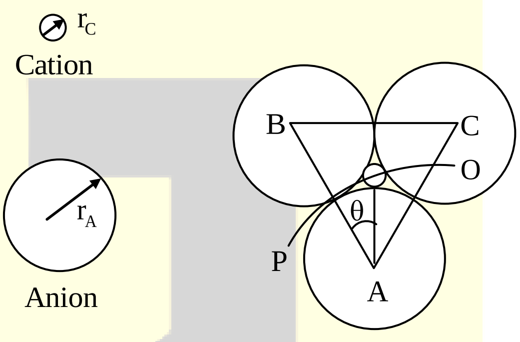
(C) 0.135

(D) 0.115

Key:(B)

Radius Ratio	Coordination number	Type of void	Example
< 0.155	2	Linear	
0.155 - 0.225	3	Triangular Planar	B_2O_3
0.225 - 0.414	4	Tetrahedral	ZnS, CuCl
0.414 - 0.732	6	Octahedral	NaCl, MgO
0.732 - 1.000	8	Cubic	CsCl, NH_4Br

For this coordination, the small cation is surrounded by three anions to form an equilateral triangle as shown here, triangle ABC; the centers of all four ions are coplanar.



This boils down to a relatively simple plane trigonometry problem. Consideration of the right triangle APO makes it clear that the side lengths are related to the anion and cation radii r_A and r_C as

$\overline{AP} = r_A$

and

$\overline{AO} = r_A + r_c$

Furthermore, the side length ratio $\overline{AP}/\overline{AO}$ is a function of the angle α as

$$\frac{\overline{AP}}{\overline{AO}} = \cos\alpha$$

The magnitude of α is 30°, since line $\overline{AO}$ bisects the 60° angle BAC. Thus,

$$\frac{\overline{AP}}{\overline{AO}} = \frac{r_A}{r_A + r_C} = \cos 30° = \frac{\sqrt{3}}{2}$$

Solving for the cation-anion radius ratio,

$$\frac{r_C}{r_A} = \frac{1-\sqrt{3}/2}{\sqrt{3}/2} = 0.155$$

57. Which of the following materials are categories of ceramic materials?

1. Oxides – Alumina, Zirconia

2. Non oxides – Carbides, Borides, Nitrides and Silicides

3. Composites – Particulate reinforced combinations of oxides and non-oxides

Select the **CORRECT** answer using the code given below.

(A) 1 and 2 only
(B) 1 and 3 only
(C) 2 and 3 only
(D) 1, 2 and 3

Key:(D)

Ceramics can also be classified into three distinct material categories:

- Oxides: alumina, beryllia, ceria, zirconia
- Non oxides: carbide, boride, nitride, silicide
- Composite materials: particulate reinforced, fiber reinforced, combinations of oxides and nonoxides.

58. Consider the following data for copper:

Energy for vacancy formation is 0.9 eV/atom

Atomic weight is 63.5 g/mol

Density is 8.4 g/cm^3 at 1000°C

The equilibrium number of vacancies per cubic meter at 1000°C will be

(A) 3.2×10^{20}
(B) 3.2×10^{25}
(C) 2.2×10^{20}
(D) 2.2×10^{25}

Key:(D)

The number of atomic sites per cubic meter for copper, from its atomic weight, A_{Cu}, its density ρ, and Avogadro's number N_A, according to

$$N = \frac{N_{A\rho}}{A_{Cu}}$$

$$= \frac{\left(6.023\times10^{23}\ \text{atoms/mol}\right)\left(8.4\text{g/cm}^2\right)\left(10^6\ \text{cm}^3/\text{m}^3\right)}{63.5\,\text{g/mol}}$$

$$= 8.0\times10^{28}\ \text{atoms / m}^3$$

Thus, the number of vacancies at 1000°C (1273 K) is equal to

$$N_v = N\exp\left(\frac{Q_v}{kT}\right)$$

$$= \left(8.0\times10^{28}\ \text{atoms/m}^3\right)\exp\left[-\frac{(0.9\ \text{eV})}{\left(8.62\times10^{-5}\ \text{eV/K}\right)(1273\ \text{K})}\right]$$

$$= 2.2\times10^{25}\ \text{vacancies/m}^3$$

59. Which of the following are electrical insulating materials?

1. Lucite

2. Mica

3. Bakelite

Select the **CORRECT** answer using the code given below.

(A) 1 and 2 only
(B) 1 and 3 only
(C) 2 and 3 only

(D) 1, 2 and 3

Key:(D)

Those substances through which electric current cannot pass easily are called insulators. e.g. Glass, Mica, dry Air, Bakelite etc.

Lucite, also called Plexiglas, Perspex, trademark name of polymethyl methacrylate, a synthetic organic compound of high molecular weight. The material has high dimensional stability and good resistance to weathering and to shock; it is colorless and highly transparent.

60. The magnitude of the energy gap for an insulator is

(A) less than 1 eV

(B) between 2 eV to 3 eV

(C) more than 3 eV

(D) between 1 eV to 2 eV

Key:(C)

Generally material having the bandgap more than 3 eV is called an insulator

61. Consider the following open – loop transfer function :

$$G = \frac{K(s+2)}{(s+1)(s+4)}$$

The characteristic equation of the unity negative feedback will be

(A) (s+1) (s+4) + K (s+2) = 0

(B) (s+2) (s+1) +K(s+4) =0

(C) (s+1) (s-2) + K (s+4) =0

(D) (s+2) (s+4) + K (s+1) = 0

Key:(A)

→ For a unity negative feedback system, the characteristic equation is given by

$$1+G=0$$

$$\Rightarrow 1+\frac{K(s+2)}{(s+1)(s+4)}=0$$

$$\Rightarrow (s+1)(s+4)+K(s+2)=0$$

62. The magnitude and phase relationship between the sinusoidal input and the steady – state output of a system is called as

(A) magnitude response

(B) transient response

(C) steady – state response

(D) frequency response

Key:(B)

→ The magnitude and phase response of a system for sinusoidal input is known as frequency response where the frequency of the input sinusoid is varied over a certain range.

63. A transfer function having all its poles and zeros only in the left- half of the s-plane is called

(A) a minimum-phase transfer function

(B) a complex transfer function

(C) an all-pass transfer function

(D) a maximum-phase transfer function

Key:(A)

→ A transfer function having all poles and zeros in left half of S-plane is known as a minimum phase system.

64. The frequency where magnitude M has a peak value in frequency response is known as

(A) normalized frequency

(B) resonant frequency

(C) peak frequency

(D) tuned frequency

Key:(B)

→The frequency where magnitude m has a peak value in frequency response in known as resonant frequency.

65. For a lead compensator having transfer function

$$G_c(s) = \frac{(s+z_c)}{(s+P_c)} = \frac{\left(s+\frac{1}{\tau}\right)}{\left(s+\frac{1}{\alpha\tau}\right)}$$

1. $\alpha = \frac{z_c}{p_c} < 1$

2. $\alpha = \frac{z_c}{p_c} > 1$

3. $\tau > 0$

4. $\tau < 0$

Which of the above are **CORRECT**?

(A) 1 and 4

(B) 1 and 3

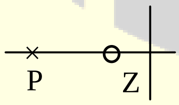
(C) 2 and 4

(D) 2 and 3

Key:(B)

→For lead compensator zero is dominant over pole

$\Rightarrow \frac{Z}{P} < 1$



→ Since all pole zero lies in left half of s-plane, τ must be positive.

→ So option B is correct.

66. The attenuation (magnitude) produced by a lead compensator at the frequency of maximum phase lead $\omega_m = \sqrt{ab}$ is

(A) $\sqrt{\frac{b}{a}}$

(B) $\sqrt{a+b}$

(C) $\sqrt{b-a}$

(D) $\sqrt{\frac{a}{b}}$

Key:(A or D)

→ For a lead compensator, maximum phase lead occurs at a frequency which is geometric mean of pole zero location i.e.

$$\omega_m = \sqrt{\left(\frac{1}{\tau}\right)\left(\frac{1}{\alpha z}\right)} = \sqrt{ab} = \sqrt{ba}$$

→ The gain at this frequency is given by $G = \frac{1}{\sqrt{\alpha}}$

→ If we assume $b = \frac{1}{\alpha z}$ and $a = \frac{1}{z}$ then

$$\sqrt{\frac{b}{a}} = \frac{1}{\sqrt{\alpha}} = G$$

→If we assume $b = \frac{1}{z}, a = \frac{1}{\pi z}$

$$\sqrt{\frac{a}{b}} = \frac{1}{\sqrt{\alpha}} = G$$

→Since no specific information given in the question regarding a,b then answer can be (A) & (D).

67. Consider the following statements:

1. A computer will have a multiply instruction.

2. Multiply instruction will be implemented by a special multiply unit.

Which of the following is **CORRECT**?

(A) Both 1 and 2 are not architectural design issues.

(B) Both 1 and 2 are not organizational issues.

(C) 1 is an architectural design issue while 2 is an organizational issue.

(D) 1 is an organizational issue while 2 is an architectural design issue.

Key:(D)

The computer organization deals with how different modules in computer connected with each other. The computer Architecture deals with the implementation of the different modules. Hence having a multiply instruction is organizational issue but implementation is an architectural issue.

68. Consider a disk with an average seek time of 4 ms, rotational delay of 2ms, rotation speed of 15000 r.p.m. and 512 byte sectors with 500 sectors per track. A file occupies all of the sectors on 5 adjacent tracks. After reading the first track, if remaining tracks can be read with no seek time, then the time required in sequential organization to transfer the file will be nearly.

(A) 0.01 second

(B) 0.034 second

(C) 0.34 second

(D) 3.4 seconds

Key:(B)

First, let us assume that the file is stored as compactly as possible on the disk. That is, the file occupies all of the sectors on 5 adjacent tracks (5 tracks = 500 sectors/ track 2500 sectors). This is known as *sequential organization*. Now, the time to read the first track is as follows:

Average seek	4ms
Average rotational delay	2ms
Read 500 sectors	4ms
	10ms

The remaining tracks can now be read with essentially no seek time. That is, the I/O operation can keep up with the flow from the disk. Then, at most, we need to deal with rotational delay for each succeeding track. Thus each successive track is read in 2+4=6 ms. To read the entire file,

Total time = 10 + (4×6) = 34 ms = 0.034 seconds

69. Add 8 and 9 in BCD code.

(A) 00010111

(B) 00010001

(C) 01110111

(D) 10001001

Key:(A)

$$(8)_{10}+(9)_{10}=(17)_{10}$$
$$(17)_{10}=[0001\ 0111]_{BCD}$$

70. Convert the binary number 11000110 to Gray code.

(A) 00100101

(B) 10100100

(C) 11100110

(D) 10100101

Key:(D)

Binary :	1⊕	1⊕	0⊕	0⊕	0⊕	1⊕	1⊕
Gray :	↓	↓	↓	↓	↓	↓	↓
	1	0	1	0	0	1	0

71. The decimal value of the signed binary number 10101010 expressed in 2's complement will be

(A) –42

(B) –86

(C) –116

(D) –170

Key:(B)

$\left.\begin{array}{l}\text{Given 2's complement}\\ \text{number}\end{array}\right\} = \text{signbit } 10101010$

The given number is a negative number due to sign bit = 1.

Take 2's complement to know the magnitude

$\Rightarrow 01010110 \Rightarrow 86$

Hence $10101010 \Rightarrow -86$

72. Which of the following statements is/are **CORRECT**?

1. An address generated by the CPU commonly referred to as a physical address.

2. An address seen by the memory unit is commonly referred to as logical address.

3. The run – time mapping from virtual to physical address is done by the memory management unit (MMU)

Select the **CORRECT** answer using the code given below.

(A) 1 only

(B) 2 only

(C) 3 only

(D) 1, 2 and 3

Key:(C)

An address generated by the CPU commonly referred to as a logical address. An address seen by the memory unit is commonly referred to as physical address.

73. In a cache with 64-byte cache lines, how many bits are used to determine which byte within a cache line an address points to?

(A) 16

(B) 8

(C) 6

(D) 3

Key:(C)

The given cache size is 64 bytes cache line

The number of bits required to determine which byte within a cache line an address points to is $\log_2 64 = 6\text{bits}$

74. A system has 64-bit virtual addresses and 43-bit physical addresses. If the pages are 8 kB in size, the number of bits required for VPN and PPN will be respectively

(A) 51 bits and 30 bits

(B) 30 bits and 51 bits

(C) 51 bits and 13 bits

(D) 3 bits and 13 bits

Key:(A)

Given that system is having 64 bits virtual address and 8 KB page size

Number of bits required in address a byte within a page is =

$\log_2(8\times 2^{10}) = \log_2(2^{13}) = 13$

Hence logical address space

$\xleftarrow{\hspace{2em}64\,bits\hspace{2em}}\!\!\rightarrow$

Virtual Page Number	page offset
51	13

Physical address space is given as 43 bits

43 bits

Physical Page Number	frame offset
30	13

75. A soft error is a

(A) regular-nondestructive event

(B) random-nondestructive event

(C) random-destructive event

(D) regular-destructive event

Key:(B)

Soft error, flaw, failure or fault in a computer program or system that causes it to produce an incorrect or unexpected result, or to behave in unintended ways. Divide by zero is an example of soft error. It's a random event.

76. A main memory can hold 3 page frames and initially all of them are vacant. Consider the following stream of page requests:

2, 3, 2, 4, 6, 2, 5, 6, 1, 4, 6

If the stream uses FIFO replacement policy, the hit ratio h will be

(A) $\frac{11}{3}$

(B) $\frac{1}{11}$

(C) $\frac{3}{11}$

(D) $\frac{2}{11}$

Key:(D)

2, 3, 2, 4, 6, 2, 5, 6, 1, 4, 6

reference string: $2-miss,\ 3-miss,\ 2-hit,\ 4-miss$

2
3
4

$6-miss,\ 2-miss,\ 5-miss,$

$\cancel{2}\,6$
$\cancel{3}\,2$
$\cancel{4}\,5$

$6,-hit\ 1-miss,\ 4-miss,\ 6-miss$

$\cancel{2}\,\cancel{6}\,1$
$\cancel{3}\,\cancel{2}\,4$
$\cancel{4}\,\cancel{5}\,6$

Hence 2 hit out of 11 references hence hit rate is $\frac{2}{11}$

77. Which one of the following is an advantage of assembly language over high-level language?

(A) Assembly language program runs faster.

(B) Writing of assembly language programming is easy.

(C) Assembly language program is portable.

(D) Assembly language program contains less instruction.

Key:(A)

Assembly code is usually faster than compiled code because assembly language coders are efficient code than a compiler generated code.

78. Which of the following statements are **CORRECT**?

1. A pseudoinstruction is a machine instruction.

2. A pseudoinstruction is an instruction to the assembler.

3. The ORG (origin) is an example of pseudoinstruction.

4. It is not possible to used ORG more than once in a program.

Select the **CORRECT** answer using the code given below.

(A) 1 and 3

(B) 2 and 3

(C) 1 and 4

(D) 2 and 4

Key:(B)

Pseudo Instructions are special commands to the assembler about the positioning of the program, the address the program should presumed to be assembled at, the name of the module, data declarations, the title and printing options for the program, defining and calling macros, macro looping and test, and end of source code. Unless a machine instruction is issued, these do not generate executable code. ORG - Set current location counter value

79. The vector R_{AB} extends from A(1, 2, 3) to B. If the length of R_{AB} is 10 units and its direction is given by

$$a = 0.6a_x + 0.64a_y + 0.48a_z$$

the coordinates of B will be

(A) $7a_x + 4.8a_y + 4.8a_z$

(B) $6a_x + 6.4a_y + 4.8a_z$

(C) $7a_x + 8.4a_y + 7.8a_z$

(D) $6a_x + 8.4a_y + 7.8a_z$

Key:(C)

$$R_{AB} = r = r_B - r_A$$

$$\gamma_A = \left(a_x + 2\hat{a}_y + 3\hat{a}_z\right)$$

$$\gamma_B = A\,ax + B\hat{a}_y + C\,\hat{a}_z$$

$$R_{AB} = \gamma_B - \gamma_A = (A-1)\hat{a}_x + (B-2)\hat{a}_y + (C-3)\hat{a}_z$$

$$|R_{AB}| = \sqrt{(A-1)^2 + (B-2)^2 + (C-3)^2} = 10$$

$$a = \frac{R_{AB}}{|R_{AB}|}$$

$$R_{AB} = 6a_x + 6.4\,a_y + 4.8\,a_z$$

$$\gamma_B = R_{AB} + \gamma_A = 7a_x + 8.4\hat{a}_y + 7.8\hat{a}_z$$

80. What is the value for the total charge enclosed in an incremental volume of $10^{-9}m^3$ located at the origin if $D=e^{-x}\sin y a_x - e^{-x}\cos y\, a_y + 2z a_z$ C/m^2?

(A) 8 nC

(B) 4 nC

(C) 2 nC

(D) 1 nC

Key:(C)

$$Q = \oint D.ds = \iiint_V (\nabla D)dv$$

[By divergence theorem]

$$\nabla.D\Big|_{(0,0,0)} = \left(-e^{-x}\sin y + e^{-x}\sin y + 2\right)\Big|_{\substack{x=0\\y=0\\z=0}} = 2\,C/m^3$$

$$Q = \iiint 2dv = 2\times10^{-9}C = 2nC$$

81. The unit vector extending from origin toward the point G(2, -2, -1) is

(A) $\frac{2}{3}a_x + \frac{2}{3}a_y + \frac{1}{3}a_z$

(B) $-\frac{2}{3}a_x+\frac{2}{3}a_y+\frac{1}{3}a_z$

(C) $\frac{2}{3}a_x-\frac{2}{3}a_y-\frac{1}{3}a_z$

(D) $-\frac{2}{3}a_x-\frac{2}{3}a_y-\frac{1}{3}a_z$

Key:(C)

We first construct the vector extending from the origin to point G,

$G=2a_x-2a_y-a_z$

We continue by finding the magnitude G,

$|G|=\sqrt{2^2+(-2)^2+(-1)^2}=3$

Finally expressed the desired unit vector as the quotient,

$a_G=\frac{G}{|G|}=\frac{2}{3}\hat{a}_x-\frac{2}{3}\hat{a}_y-\frac{1}{3}\hat{a}_z$

$=0.667\hat{a}_x-0.667\hat{a}_y-0.333\hat{a}_z$

82. Ground waves progress along the surface of the earth and must be polarized

(A) horizontally

(B) circularly

(C) elliptically

(D) vertically

Key:(D)

Ground wave is produced by vertically polarized antennas. Any horizontal component of electric field with earth is shat circuit by earth

83. For a lossless line terminated in a short circuit, the stationary voltage minima and maxima are separated by

(A) $\frac{\lambda}{8}$

(B) $\frac{\lambda}{2}$

(C) $\frac{\lambda}{3}$

(D) $\frac{\lambda}{4}$

Key:(D)

We know that

$Z_{min}=\frac{-1}{2\beta}(\phi+(2m+1)\pi):m=0,1,2$

$Z_{max}=-\frac{1}{2\beta}(\phi+2m\pi);\ m=0,1,2$

Reflection coefficient

$\pi=\frac{Z_L-Z_0}{Z_L+Z_0};$

If $Z_L=0$; i.e short circuit load

$\pi=1<\pi=1<180°$

1. $Z_{min}=-\frac{1}{2\beta}(2\pi)=-\frac{\pi}{\beta},m=0$

$\beta=\frac{2\pi}{\lambda};Z_{min}=\frac{-\lambda}{2}$

2. $Z_{max}=\frac{-1}{2\beta}(\pi)=-\frac{\lambda}{4},m=0$

$Z_{man}-Z_{min}=-\frac{\lambda}{4}+\frac{\lambda}{2}=\frac{\lambda}{4}$

84. The characteristic impedance of an 80 cm long lossless transmission line having L=0.25 $\mu H/m$ and C =100 pF/m will be

(A) 25Ω

(B) 40Ω

(C) 50Ω

(D) 80Ω

Key:(C)

In Transmission line characteristic impedance can be defined as

$$Z_0 = \sqrt{\frac{R + j\omega L}{G + j\omega C}}$$

In case of lossless R = G =0

$$Z_0 = \sqrt{\frac{L}{C}} = \sqrt{\frac{0.25 \times 10^{-6}}{10^{-10}}} = \sqrt{\frac{25 \times 10^{-8}}{10^{-10}}}$$

$$= 5 \times 10 = 50\Omega$$

$2:1$ i.e., $\frac{a}{b} = \frac{2}{1} \Rightarrow a = 2b$

T_{M11} mode $\lambda_c = \frac{2}{\sqrt{\frac{1}{a^2} + \frac{1}{b^2}}}$

$$= \frac{2a}{\sqrt{5}} = 0.89a \approx 0.9a$$

85. It is required to match a $200\,\Omega$ load to a 300 Ω transmission line to reduce the SWR along the line to 1. If it is connected directly to the load, the characteristic impedance of the quarter wave transformer used for this purpose will be

(A) $275\,\Omega$

(B) $260\,\Omega$

(C) $245\,\Omega$

(D) $230\,\Omega$

Key:(C)

$Z_{in} = \frac{Z_0^2}{Z_L}$ In case of quarters wave matching

$$Z_0 = \sqrt{Z_{in} . Z_L} = \sqrt{200 \times 300}$$

$$= \sqrt{6} \times 100 = 245\Omega$$

86. For a standard rectangular waveguide having an aspect ratio of 2:1, the cut-off wavelength for $TM_{1,1}$ mode will be nearly

(A) 0.9a

(B) 0.7a

(C) 0.5a

(D) 0.3a

Key:(A)

For a standard waveguide aspect ratio of

87. The irises in the rectangular metallic waveguide may be

1. inductive

2. resistive

3. capacitive

Select the **CORRECT** answer using the code given below.

(A) 1, 2 and 3

(B) 1 and 2 only

(C) 1 and 3 only

(D) 2 and 3 only

Key:(C)

The irises in the metallic wave guide can be classify as

1. Inductive
2. Capacities
3. Tune circuit (LC)

88. A 10 GHz signal is propagated in a waveguide whose wall separation is 6cm. The greatest number of half waves of electric intensity will be possible to establish between the two walls. The guide wavelength for this mode of propagation will be

(A) 6.48cm

(B) 4.54cm

(C) 2.48cm

(D) 1.54cm

Key:(B)

$$f_c(10)=\frac{C}{2a}=2.5\,\text{GHz}$$

Highest possible is $f_c(30)=7.5\,\text{GHz}$

$$\bar{\lambda}\frac{\lambda}{\sqrt{1-\left(\frac{f_c}{f}\right)^2}}=\frac{3\text{cm}}{1-\left(\frac{7.5}{10}\right)^2}$$

$$=4.535\text{ cm}$$

89. In $TE_{m,n}$ mode, m and n are integers denoting the number of

(A) $\frac{1}{2}$ the wavelengths of intensity between each pair of walls

(B) $\frac{1}{3}$ the wavelengths of intensity between each pair of walls

(C) $\frac{1}{4}$ the wavelengths of intensity between each pair of walls

(D) $\frac{1}{8}$ the wavelengths of intensity between each pair of walls

Key:(A)

In Rectangular wave guide TE_{mn} modes where m, n are represents the number of half-cycle variations in x and y directions

90. Consider the following statements with reference to dipole arrays:

1. In broadside array, all the dipoles are fed in the same phase from the same source.

2. In end-fire array, the magnitude of the current in each element is same and there is no phase difference between these currents.

Which of the above statements is/are CORRECT?

(A) 1 only

(B) 2 only

(C) Both 1 and 2

(D) Neither1 nor 2

Key:(A)

We know that

$$\psi=\beta d\cos\phi+\alpha$$

1. In broad side array has main beams that occur normal to the array plane $\left(\theta=\frac{\pi}{2},3\frac{\pi}{2}\right)$

The condition for this is that principle maximum, $\psi=0$, will occurs at their angles.

$\psi=0=\beta d\cos\frac{\pi}{2}+\alpha,$ So, we would set $\alpha=0$, which is current elements are in phase

2. An end-fix array a principal maximum to occur along the axis $\phi=0$,

$$\psi=0=\beta d\cos 0^\circ+\alpha,\text{ so, }\alpha=-\beta d$$

91. In a 440V, 50Hz transformer, the total iron loss is 3700 W. When the applied voltage is 220 V at 25 Hz, the total iron loss is 750 W. The eddy current loss at the normal voltage and frequency will be

(A) 1000 W

(B) 1200 W

(C) 1400 W

(D) 1850 W

Key:(*)

1. $440V, 50Hz, w_i=3700W$
2. $220v,\ 25Hz,\ w_i=750W$

$W_e=?$

(1) $\frac{V_1}{f_1} = \frac{440}{50} = 8.8$

(2) $\frac{V_2}{f_2} = \frac{220}{25} = 8.8$

v/f ratio is constant

$\therefore w_i = Af + Bf^2$

$3700 = A \times 50 + B \times 50^2 \quad ...(1)$

$750 = A \times 25 + B \times 25^2 \quad ...(2)$

By solving (1) and (2) we get

$B = \frac{2200}{1250}$

$W_e = Bf^2$

$= \frac{2200}{1250} \times 50 \times 50 = 4400W$

(Answer not given in the option)

92. A transformer core is wound with a coil carrying an alternating current at a frequency of 50Hz. The hysteresis loop has an area of 60000 units, when the axes are drawn in units of 10^{-4} Wb m^{-2} and 10^2 Am^{-1}. If the magnetization is uniform throughout the core volume of $0.01m^3$, then the hysteresis loss will be

(A) 200 W

(B) 230 W

(C) 270 W

(D) 300 W

Key:(D)

$W_n = 60000 \times 50 \times 10^{-4} \times 10^2 \times 0.01 = 300W.$

93. The process of evaporating a metal in an inert atmosphere and allowing it to condense on the surface of a cold finger, which is kept at liquid nitrogen temperature of 77K, is known as

(A) d.c. arc method

(B) gas – phase condensation

(C) Sonohydroglysis

(D) flame pyrolysis

Key:(B)

94. Which one of the following materials is having the highest electrical conductivity at room temperature?

(A) Silver

(B) Copper

(C) Gold

(D) Platinum

Key:(A)

Material	Resistivity **$\rho(\Omega.m)$ at 20°C**	Conductivity **$\sigma(S/m)$ at 20°C**
Silver	1.59×10^{-8}	6.30×10^7
Copper	1.68×10^{-8}	5.96×10^7
Gold	2.44×10^{-8}	4.1×10^7
Aluminium	2.65×10^{-8}	3.77×10^{-7}
Platinum	1.06×10^{-7}	9.43×10^6

The inert gas evaporation–condensation (IGC) technique, in which nano particles are formed via the evaporation of a metallic source in an inert gas, has been widely used in the synthesis of ultrafine metal particles

95. Consider the following processes:

1. Sol-gel process

2. Electrode position

3. Plasma-enhanced vapour decomposition

4. Gas – phase condensation

5. Sputtering technique

The above processes are related to

(A) analysis of nano – powders

(B) sintering of nano – powders

(C) synthesis of nano – powders

(D) microwave sintering of nano powders

Key:(C)

96. In the superconducting state, the flux lines of a magnetic field are ejected out of the superconductor as per

(A) Curie effect

(B) Faraday's effect

(C) Maxwell's effect

(D) Meissner effect

Key:(D)

The Meissner effect is the expulsion of a magnetic field from a superconductor during its transition to the superconducting state

97. A null type of instrument as compared to a deflection type of instrument

(A) has a higher accuracy

(B) is less sensitive

(C) is more rugged

(D) is faster in response

Key:(A)

97. A null-type of instrument as compared to a deflection type of instrument has a higher accuracy. Because, in null-type instrument, the opposing effect is calibrated with the help of standards which have very high accuracy. However, in deflection type instrument, the caliberation depends upon the instrument contacts which are generally not known to a high degree of accuracy. i.e. option (a)

98. A wheatstone bridge requires a change of 7 Ω in the unknown resistance arm of the bridge to produce a change in deflection of 3mm of the galvanometer. The sensitivity and the deflection factor will be nearly

(A) 0.23 mm/Ω and 2.3 Ω/mm

(B) 0.43 mm/Ω and 2.3 Ω/mm

(C) 0.23 mm/Ω and 1.3 Ω/mm

(D) 0.43 mm/Ω and 1.3 Ω/mm

Key:(B)

Change in resistance $= 7\Omega$

Deflection = 3 mm.

Sensitivity of wheat stone bridge

$$= \frac{\text{change is deflection in galvanometer}}{\text{Change in resistance}}$$

$$= \frac{3}{7}\,\text{mm}/\Omega = 0.43\,\text{mm}/\Omega$$

$$\text{Deflection factor} = \frac{1}{\text{sensitivity}}$$

$$= \frac{1}{3/7} = 7/3 = 2.3\Omega/\text{mm}$$

99. The galvanometer used in a wheatstone bridge as a detector can detect a current as low as 0.1nA and its resistance is negligible compared to internal resistance of the bridge. Each arm of the bridge has a resistance of 1k Ω. The input voltage applied to the bridge is 20V. The smallest change in the resistance that can be detected is

(A) 10 $\mu\Omega$

(B) 20 $\mu\Omega$

(C) 30 $\mu\Omega$

(D) 40 $\mu\Omega$

Key:(B)

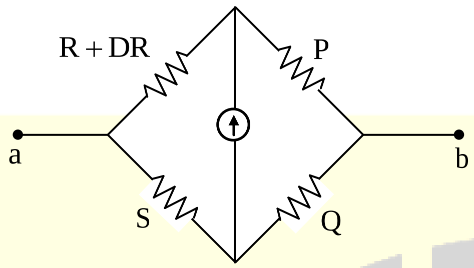
$I_g = 0.1\text{nA}\ R = 1\text{K}\Omega,\ V_{is} = 20\text{V}$

Thevenin's resistance of bridge

$$R_{.0}=\frac{RS}{R+S}+\frac{PQ}{P+Q}$$

$P=Q=R=S=1K\Omega$

$R_0=R=1K\Omega$



Output voltage of budge due to unbalance

$$V_0=V\frac{\Delta R}{4R}=20\times\frac{\Delta R}{4\times1000}=5\times10^{-3}\Delta R$$

Current through galvanometer, $I_g=\frac{V_0}{R_g}$

$$0.1\times10^{-9}=\frac{5\times10^{-3}\Delta R}{1000}$$

$\Delta R=20\mu\Omega$

100. The inductance of a 25 A electrodynamic ammeter changes uniformly at the rate of $0.0035\,\mu$H/ degree. The spring constant is 10^{-6}N/m/degree. The angle of deflection at full scale will be

(A) 135°

(B) 125°

(C) 115°

(D) 105°

Key:(B)

$dm/d\theta=0.0035\,\mu H/\text{degree}$

$K=10^{-6}\,Nm/\text{degree}$

$I=25A$

For an electrodynamometer, deflecting torque

$$T_d=I^2\frac{dm}{d\theta}\text{ and }T_C=K\theta$$

At steady state, $T_d=T_c$

$$K.\theta=I^2\frac{dm}{d\theta}$$

$$\theta=\frac{I^2}{K}.\frac{dm}{d\theta}$$

Converting $\frac{dm}{d\theta}$ is to H/rad

$$=\frac{0.035\times10^{-6}}{\pi/180}=0.2\times10^{-6}\text{ H/rad.}$$

$$\text{Now }\theta=\frac{(25)^2}{10^{-6}}\times0.2\times10^{-6}=125°$$

101. A resistance is determined by voltmeter ammeter method. The voltmeter reads 100V with a probable error of ±12V and the ammeter reads 10 A with a probable error of ±2A. The probable error in the computed value of the resistance will be nearly

(A) $0.6\,\Omega$

(B) $1.3\,\Omega$

(C) $2.3\,\Omega$

(D) $3.6\,\Omega$

Key:(D)

$$R=V/I=\frac{100\pm12\%}{10\pm20\%}=10\pm32\%$$

Actual error $=10\times0.32=3.2\Omega$

$\approx$ Nearest Answer 3.6

102. A temperature – sensing device can be modeled as a first – order system with a time constant of 6s. It is suddenly subjected to a step input of 25°C-150°C. The indicated temperature in 10s after the process has started will be

(A) 118.2 °C

(B) 126.4°C

(C) 134.6°C

(D) 142.8°C

Key:(B)

$\theta_1 = 25°C, \theta_2 = 150°C. \tau = 6\text{sec}$

$\theta = \theta_2 + (\theta_1 - \theta_2)e^{-t/\tau}$

$= 150 + (25 - 150)e^{-10/6} = 126.4°C$

103. In a parallel circuit having two branches, the current in one branch is $I_1 = 100 \pm 2A$ and in the other is $I_2 = 200 \pm 5A$. Considering errors in both I_1 and I_2 as limiting errors, the total current will be

(A) $300 \pm 5A$

(B) $300 \pm 6A$

(C) $300 \pm 7A$

(D) $300 \pm 8A$

Key:(C)

$I_1 = 100 \pm 2; \quad I_2 = 200 \pm 5$

For parallel network,

$I = I_1 + I_2 = 100 + 200 = 30A$

$$\frac{\delta I}{I} = \pm\left[\frac{I_1}{I}.\frac{\delta I_1}{I_1} + \frac{I_2}{I}.\frac{\delta I_2}{I_2}\right]$$

$$\frac{\delta I}{I} = \pm\left[\frac{100}{300}\times 0.02 + \frac{200}{300}\times 0.025\right]$$

$$\frac{\delta I}{I} = \pm\frac{0.07}{3}\times I = \pm 7\Omega$$

$300 \pm 7\Omega$

104. A 0 – 150 V voltmeter has a guaranteed accuracy of 1% of full-scale reading. The voltage measured by this instrument is 75V. The limiting error will be

(A) 5%

(B) 3%

(C) 3%

(D) 2%

Key:(D)

Guaranteed accuracy error = 1% of full scale reading.

$V = 75V; (0 - 150V)$

Absolute accuracy $= 150 \times \frac{1}{100} = 1.5V$

For measuring 75V, it may indicate $(75 \pm 1.5)V$

Hence, limiting error $= \frac{1.5}{75}\times 100 = 2\%$

105. A quartz piezoelectric crystal having a thickness of 2mm and voltage sensitivity of 0.055V m/N is subjected to a pressure of $1.5MN/m^2$. The voltage output will be

(A) 165V

(B) 174V

(C) 183V

(D) 192 V

Key:(A)

Thickness, t = 2 mm, voltage sensitivity g = 0.055 Vm/N

$P = 1.5 MN/m^2$

Output voltage, $V_0 = g.\,pt$

$= 0.055 \times 1.5 \times 2 \times 10^{-3} = 165V$

106. A resistance wire strain gauge with a gauge factor of 2 is bonded to a steel structural member subjected to a stress of $100MN/m^2$. The modulus of elasticity of steel is 200 GN/m^2. The change in the value of gauge resistance due to the applied stress will be

(A) 0.05%

(B) 0.10%

(C) 0.30%

(D) 0.60%

Key:(B)

$$\text{Modules of elasticity} = \frac{\text{Stress}}{\text{Strain}}$$

$$\therefore \text{strain} = \frac{100\times10^6}{200\times10^9} = 5\times10^{-4}$$

Gauge factor

$$= G_f = \frac{\Delta R/R}{\Delta\ell/\ell} = \frac{\Delta R/R}{\text{Strain}}$$

$$2 = \frac{\Delta R/R}{5\times10^{-4}}$$

$$\Delta R/R = 10^{-3} = 0.001$$

$\therefore$ Percentage in resistance = 0.1%

107. The applications of photomultipliers are seen in

(A) night vision equipment, medical equipment

(B) mechanical counters, timers

(C) translational, optical instruments

(D) ultrasonic transducer, infrared imaging

Key:(A)

Photo multipliers are used is night vision equipment, medical equipment for blood analysis & precise capture of image.

108. A capacitance of 250 pF produces resonance with a coil at a frequency of $\left(\frac{2}{\pi}\right)\times10^6$ Hz, while at the second harmonic of this frequency, resonance is produced by a capacitance of 50pF. The self-capacitance of the coil will be nearly

(A) 16.7 pF

(B) 20.5 pF

(C) 24.3pF

(D) 28.1 pF

Key:(A)

If the circuit is in resonance,

$$\text{i.e., } f = \frac{1}{2\pi\sqrt{L(C_1+C_d)}}$$

At second harmonic frequency =2f.

$$2f = \frac{1}{2\pi\sqrt{L(C_2+C_d)}}$$

$$\text{Then } \frac{2f}{F} = \sqrt{\frac{C_1+C_d}{C_2+C_d}}$$

$$\therefore C_d = \frac{C_1-4C_2}{3} = \frac{250-(4\times50)}{3} = 16.67\text{pF}$$

109. Consider the following data for twigs and links:

N = Number of nodes

L = Total number of branches

B = Total number of branches

The total number of links associated with a tree is

(A) B – N + 1

(B) B – N – 1

(C) B + N + 1

(D) 2B – N + 1

Key:(A)

$$L = B - N + 1$$

It is a standard result, where

L: number of Links

B: number of Branch

N: number of Node

110. In ABCD parameters, A and C are called

(A) reverse current ratio and transfer admittance

(B) reverse voltage ratio and transfer impedance

(C) reverse current ratio and transfer impedance

(D) reverse voltage ratio and transfer admittance

Key:(D)

$$\rightarrow V_1 = AV_2 - BI_2$$
$$I_1 = CV_2 - DI_2$$

$$\rightarrow A = \left.\frac{V_1}{V_2}\right|_{I_2=0} \frac{\text{I/P voltage}}{\text{O/P voltage}} = \text{Reverse voltage ratio}$$

$$\rightarrow C = \left.\frac{I_1}{V_2}\right|_{I_2=0} = \frac{\text{I/P current}}{\text{O/P voltage}} = \text{Transfer admitance}$$

111. A coil having resistance of $10\,\Omega$ and inductance of 1 H is switched on to a direct voltage of 100V. The steady-state value of the current will be

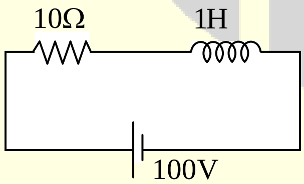
(A) 10A

(B) 15A

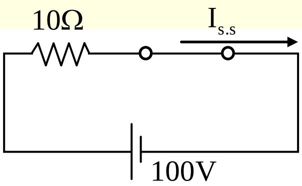
(C) 20A

(D) 25A

Key:(A)



As steady state inductor behaves as short circuit, so



$$i_{ss} = \frac{100}{10} = 10A.$$

112. A coil has $R = 10\,\Omega$ and $L = 15H$. The voltage at the instant when the current is 10A and increasing at the rate of 5A/s will be

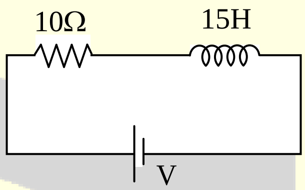
(A) 125V

(B) 150V

(C) 175V

(D) 200V

Key:(C)

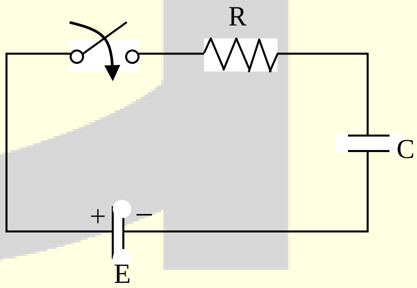


$$V = 10i(t) + 15\frac{di}{dt}$$

$$V(10\times10) + [15\times5]$$

$$= 175V\left(\because \text{it is given } i = 10, \frac{di}{dt} = 5\right)$$

113. Consider the following RC circuit. The capacitor has an initial charge q_0 such that it opposes the flow of charging current:



The response of the circuit i(t) will be

(A) $\left(\frac{E}{R} - \frac{q_0}{RC}\right)e^{-\frac{t}{RC}}$

(B) $-\frac{q_0}{RC}e^{-\frac{t}{RC}}$

(C) $\frac{E}{R}e^{-\frac{t}{RC}}$

(D) $\left(\frac{E}{R} + \frac{q_0}{RC}\right)e^{-\frac{t}{RC}}$

Key:(A)

$Q = CV$

$V_0 = \frac{q_0}{C}$

$V_{c(t)} = E + \left[\frac{q_0}{c} - E\right]e^{-t/RC}$

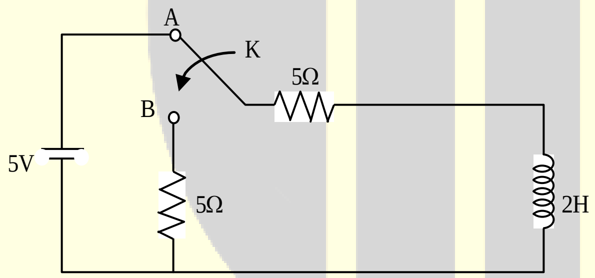
$i_{c(t)} = C\frac{d}{dt}\left[\frac{q_0}{c} - E\right]e^{-t/RC}$

$= C\left[\frac{q_0}{C} - E\right]\left(-\frac{1}{RC}\right)e^{-t/RC}$

$= -\frac{1}{R}\left[\frac{q_0}{C} - E\right]e^{-t/RC}$

$= \left[\frac{E}{R} - \frac{q_0}{RC}\right]e^{-t/RC}$

114. In the following circuit, switch K is thrown from position A to position B at time t = 0, the current having previously reached its steady state:



The Current i(t) after switching will be

(A) $5e^{-5t}$

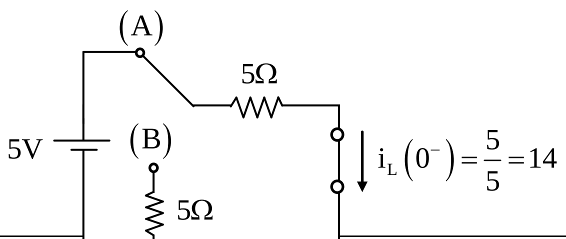
(B) $4e^{-5t}$

(C) $3e^{-5t}$

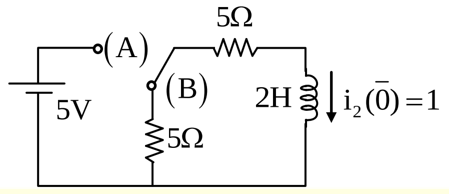
(D) e^{-5t}

Key:(D)

At $t = 0^-$. Switch at A, network is in steady state L is short circuit.



For $t > 0$, switch at B



$i_L(t) = i_L(\bar{0})e^{-t(R/L)} = 1e^{-t\frac{10}{2}} = e^{-5t}$

115. What is the condition for reciprocity and symmetry in Y-parameter representation?

(A) $Y_{21} = Y_{11}$ and $Y_{22} = Y_{21}$

(B) $Y_{21} = Y_{12}$ and $Y_{11} = Y_{22}$

(C) $Y_{21} = Y_{22}$ and $Y_{11} = Y_{22}$

(D) $Y_{11} = Y_{22}$ and $Y_{21} = Y_{22}$

Key:(B)

For 2 port Y matrix

The symmetry condition B: $Y_{11} = Y_{22}$

Reciprocity condition: $Y_{12} = Y_{21}$

116. In hybrid parameters, h_{11} and h_{21} are called as

(A) input impedance and forward current gain

(B) reverse voltage gain and output admittance

(C) input impedance and reverse voltage gain

(D) output impedance and forward current gain

Key:(A)

$V_1 = h_{11}I_1 + h_{12}V_2$

$I_2 = h_{21}I_1 + h_{22}V_2$

$$\rightarrow h_{11} = \left.\frac{V_1}{I_1}\right|_{V_2=0} = \frac{\text{I/P voltage}}{\text{I/P current}}$$

$$= \text{I/P impedance}$$

$$\rightarrow h_2 = \left.\frac{I_2}{I_1}\right|_{V_2=0} \frac{\text{O/P current}}{\text{I/P current}}$$

$$= \text{forward current gain}$$

117. Consider the following equations:

$V_1 = 6V_2 - 4I_2$

$I_1 = 7V_2 - 2I_2$

A, B, C and D parameters are

(A) 6, – 4 Ω, 7 mho and – 2

(B) 6, 4 Ω, 7 mho and 2

(C) –6, 4 Ω, –7 mho and 2

(D) 6, 4 Ω, –7 mho and – 2

Key:(B) $\rightarrow V_1 = AV_2 - BI_2$

$I_1 = CV_2 - DI_2$

$\rightarrow$ it is given that

$V_1 = 6V_2 - 4I_2$

$I_1 = 7V_2 - 2I_2$

$\rightarrow$ By comparing both set

$A = 6, B = 4, C = 7, D = 2$

118. A supply of 250V, 50Hz is applied to a series RC circuit. If the power absorbed by the resistor be 400W at 160V, the value of the capacitor C will be nearly

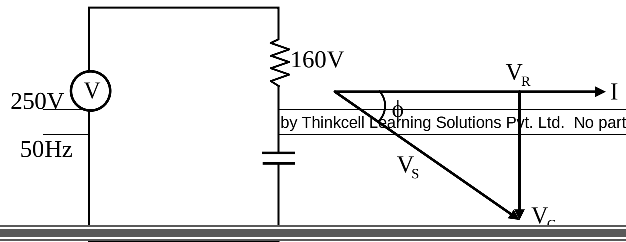
(A) 30.5 μF

(B) 41.5 μF

(C) 64.0 μF

(D) 76.8 μF

Key:(B)



$$V_C = \sqrt{V_S^2 - V_R^2}$$

$$= \sqrt{250^2 - 160^2} = \sqrt{62500 - 25600}$$

$$= \sqrt{36900} = 192.09 \simeq 192$$

$$\rightarrow P_R = 400\text{ W} \Rightarrow \frac{V_R^2}{R} = 400$$

$$\Rightarrow R = \frac{V_R^2}{400} = \frac{160^2}{400}$$

$$= 64\Omega \rightarrow \sin\phi = \frac{V_C}{V_S} = \frac{192}{250} = 0.768$$

$$\rightarrow I = \frac{160\text{ V}}{64} = 2.54$$

$$\rightarrow Z = \frac{|\bar{V}_S|}{|\bar{I}|} = \frac{250}{2.5} = 100$$

$$\rightarrow X_C = |Z|\sin\phi = 100 \times 0.768 = 76.8$$

$$\Rightarrow \frac{1}{\omega c} = 76.8$$

$$\Rightarrow C = \frac{1}{\omega \times 76.8}$$

$$= \frac{1}{2\pi \times 50 \times 76.8} = 41.5\ \mu\text{F}$$

119. A 50Hz sinusoidal voltage V = 311 sin ωt is applied to an RL series circuit. If the magnitude of resistance is 5 Ω and that of the inductance is 0.02 H, the r.m.s. value of the steady-state current and the relative phase angle are nearly

(A) 19.6A and 51.5°

(B) 27.4 A and –51.5°

(C) 19.6A and –51.5°

(D) 27.4A and 51.5°

Key:(D)

$$I_{rms} = \frac{V_{rms}}{2} = \frac{\frac{311}{\sqrt{2}}\angle 0^\circ}{5 + j2\pi\times 50\times 0.02}$$

$$= 27.4\angle -51.5^\circ$$

120. In a series RC circuit, the values of R = 10 Ω and C = 25nF. A sinusoidal voltage of 50 MHz is applied and the maximum voltage across the capacitance is 2.5V. The maximum voltage across the series combination will be nearly

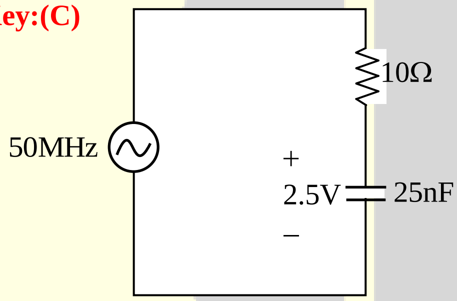
(A) 172.7V

(B) 184.5V

(C) 196.3V

(D) 208.1V

Key:(C)



$$\rightarrow Z_c = \frac{-j}{\omega C} = \frac{-j}{2\pi\times 50\times 10^6\times 25\times 10^{-9}}$$

$$= \frac{-j}{2500\pi}1000 = \frac{-10j}{25\pi} = -(0.127)j$$

$$\rightarrow I = \frac{2.5}{0.127} = 196.8$$

$$\rightarrow V_R = 101 = 196.8$$

$$\rightarrow V_s = \sqrt{V_R^2 + V_C^2}$$

$$= \sqrt{(196.8)^2 + (2.9)^2} = \sqrt{38750 + 6.25}$$

$$= 196.86 \simeq 196.3$$

121. The peak-to-peak ripple voltage for a half-wave rectifier and filter circuit operating at 60Hz, which has a 680 μF reservoir capacitor, an average output of 28V and 200 Ω load resistance, will be nearly

(A) 2.5V

(B) 3.4V

(C) 4.3V

(D) 5.2V

Key:(*)

$$V_R \approx \frac{V_P - V_{D.on}}{R_L}\cdot\frac{T_{in}}{C_1} \approx \frac{V_p - V_{D.on}}{R_L C_1 f_{in}}$$

Peak to peak ripple voltage for half wave rectifier with capacitor filter is

$$V_R \approx \frac{V_m - V_{Don}}{R_L Cf};\ \text{Given}\ \frac{V_m}{\pi} = 28\ \text{volt}$$

For ideal diode

$$V_{DON} = 0.7\ \text{volt.}$$

$$V_R = \frac{28\times\pi - 0.7}{200\times 680\times 10^{-6}\times 60} = 10.69\ \text{volt}$$

122. The components of full-wave voltage doubler circuit are

(A) 2 diodes and 1 capacitor

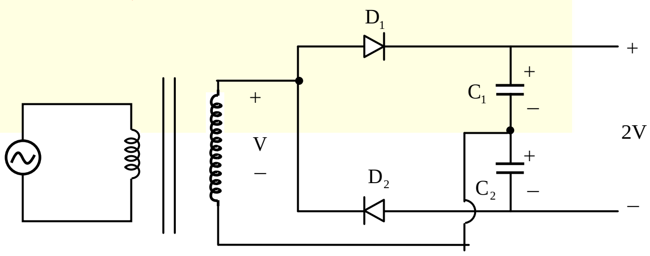
(B) 4 diodes and 1 capacitor

(C) 2 diodes and 2 capacitors

(D) 4 diodes and 2 capacitors

Key:(C)

A full wave voltage doublers is as shown below:



123. An amplifier has a signal input voltage V_i of 0.25V and draws 1 mA from the source. If the amplifier delivers 8V to a load of 10mA, the power gain is

(A) 340

(B) 320

(C) 250

(D) 150

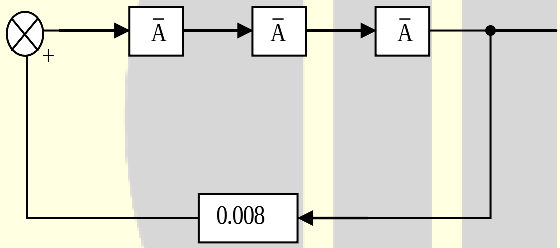
Key:(B)

$$\text{Power gain} = \frac{V_{out}I_{out}}{V_{in}I_{in}} = \frac{8\times10\times10^{-3}}{0.25\times1\times10^{-3}} = 320$$

124. Three amplifiers of gain

$$\bar{A} = \left(\frac{A_0}{2}\right)\angle -60°$$

are connected in tandem. The feedback loop is closed through a positive gain of 0.008:



The magnitude of A_0 for the system to be oscillatory will be

(A) 0.2

(B) 0.1

(C) 5.0

(D) 10.0

Key:(D)

$$A = \bar{A}\bar{A}\bar{A} = \left(\frac{A_0}{2}\right)\underline{|60°}\left(\frac{A_0}{2}\right)\underline{|-60°}\left(\frac{A_0}{2}\right)\underline{|-60°}$$

$$A = \frac{A_0^3}{8}\underline{|-180°};\ \beta = 0.008$$

$$A\beta = 1$$

$$\frac{A_0^3}{8}\times0.008 = 1 \Rightarrow A_0^3 = 1000 \Rightarrow A_0 = 10$$

125. The output voltage from a 5-bit ladder type DAC that has a digital input of 11010, and by assuming 0 = 0 V and 1 = + 10V, is nearly

(A) 26.0V

(B) 16.3V

(C) 10.3V

(D) 8.1V

Key:(D)

For a 5 bit ladder type DAC

$$V_0 = V_{FS}\left[\frac{b_4}{2^1}+\frac{b_3}{2^2}+\frac{b_2}{2^3}+\frac{b_1}{2^4}+\frac{b_0}{2^5}\right]$$

$$=10\left[\frac{1}{2}+\frac{1}{4}+\frac{0}{8}+\frac{1}{16}+\frac{0}{32}\right]$$

$$V_0 = 8.125V$$

126. An 8-bit D/A converter has step size of 20mV. The full-scale output and the resolution will be nearly

(A) 5.1V and 0.3%

(B) 4.6V and 0.4%

(C) 5.1V and 0.04%

(D) 4.6V and 0.3%

Key:(A)

$$\text{Step size } \Delta = \frac{V_{FS}}{2^n - 1}$$

$$V_{FS} = \Delta\left(2^n - 1\right)$$

$$n = 8$$

$$V_{Fs} = 20\times10^{-3}\left[2^8 - 1\right]$$

$$= 5.1\text{volt}$$

$$\text{Resolution} = \frac{1}{2^n - 1}\times100\ \%$$

$$= \frac{1}{2^8 - 1}\times100 = 0.392\%$$

127. For 555 astable multivibrator, if C = 0.01 μF, R_A = 10 kΩ, R_B = 50 kΩ, the frequency and the duty cycle will be nearly

(A) 1.6 kHz and 54.5%

(B) 1.3 kHz and 54.5%

(C) 1.6 kHz and 46.5%

(D) 1.3 kHz and 46.5%

Key:(B)

$$f=\frac{1.45}{(R_A+2R_B)C}$$

$$=\frac{1.45}{\left(10\times10^2+2\times50\times10^3\right)0.01\times10^{-6}}$$

$$=1309\text{ Hz}$$

$$f=1.31\text{ KHz}$$

Duty cycle

$$=\frac{R_B}{R_A+2R_B}\times100=\frac{50}{110}\times100=45.45\%$$

128. Consider the following expression:

$$A\cdot B\cdot C\cdot D+A\cdot B\cdot\bar{C}\cdot\bar{D}+A\cdot B\cdot C\cdot\bar{D}+$$
$$A\cdot B\cdot\bar{C}\cdot D+A\cdot B\cdot C\cdot D\cdot E+$$
$$A\cdot B\cdot\bar{C}\cdot\bar{D}\cdot\bar{E}+A\cdot B\cdot\bar{C}\cdot D\cdot E$$

The simplification of this by using theorems of Boolean algebra will be

(A) A+B

(B) $A\oplus B$

(C) (A+B) $(A\cdot B)$

(D) $A\cdot B$

Key:(D)

$$F=ABCD+ AB\bar{C}\bar{D}+ABC\bar{D}$$
$$+AB\bar{C}D+ABCDE+AB\bar{C}\bar{D}\bar{E}$$
$$+AB\bar{C}DE$$

$$=ABD+AB\bar{D}+ABDE+AB\bar{C}\bar{D}\bar{E}$$
$$=AB+AB\left[DE+\bar{C}\bar{D}\bar{E}\right]$$
$$=AB\left[1+DE+\bar{C}\bar{D}\bar{E}\right]=AB$$

129. An electric power generating station supplies power to three loads A, B and C. Only a single generator is required when any one load is switched on. When more than one load is on, an auxiliary generator must be started. The Boolean equation for the control of switching of the auxiliary generator will be

(A) AA + BB + CC

(B) ABC + BCA + CAB

(C) AB + AC

(D) AB + AC + BC

Key:(D)

	A	B	C	F (Function for the Auxiliary generator)
0	0	0	0	0
1	0	0	1	0
2	0	1	0	0
3	0	1	1	1
4	1	0	0	0
5	1	0	1	1
6	1	1	0	1
7	1	1	1	1

F= AB+BC+AC

	$\bar{B}\bar{C}$	$\bar{B}C$	BC	$B\bar{C}$
$\bar{A}$	0	1	1 3	2
A	4	1 5	1 1	1 6

130. Which one of the following types of instructions will be used to copy from the source to the destination location?

(A) Arithmetic instructions

(B) Data transfer instructions

(C) Logical instructions

(D) Machine control instructions

Key:(B)

Data transfer instructions are used to copy to data between source and destination.

131. A cascaded arrangement of flip-flops where the output of one flip-flop drives the clock input of the following flip-flop, is known as

(A) Synchronous counter

(B) Ripple counter

(C) Ring counter

(D) Up counter

Key:(B)

In ripple counters the flip flops are incase code connection. The output transition of each flip flop triggers the next flip flop

132. The number of flip- flops required to construct an 8-bit shift register will be

(A) 32

(B) 16

(C) 8

(D) 4

Key:(C)

An 'n' bit shift register needs 'n' number of flip flops.

So, the 8 bit shift register needs '8' number of flip flops.

133. Which one of the following specifications does not fit for a single mode fiber?

(A) The bandwidth is 1GHz/km.

(B) The digital communication rate is excess of 2000Mbytes/s.

(C) More than 100000 voice channels are available.

(D) The mode field diameter (MFD spot size) is larger than the correct diameter.

Key:(D)

MFD for single fiber mode is 7 to 11 μm

Core diameter of single-mode fiber

134. For a binary FSK signal with a mark frequency of 49 kHz, a space frequency of 51 kHz and an input bit rate of 2 kbps, the peak frequency deviation will be

(A) 0.5 kHz

(B) 1.0 kHz

(C) 2.0 kHz

(D) 4.0kHz

Key:(B)

$$\Delta f = \frac{|49K - 51K|}{2} = 1.0\text{ KHz}$$

135. A random process X(t) is defined as X(t) = $2\cos(2\pi t + Y)$ Where Y is a discrete random variable with $P(Y=0)=\frac{1}{2}$ and $P\left(Y=\frac{\pi}{2}\right)=\frac{1}{2}$.

The mean $\mu_x(1)$ is

(A) $\frac{1}{4}$

(B) $\frac{1}{3}$

(C) $\frac{1}{2}$

(D) 1

Key:(D)

$$\mu_x(1) = \sum_Y 2\cos(2\pi + Y)P(Y)$$

$$= 2\sum_y \cos Y\, p(Y)$$

$$= (2)\left[1.\frac{1}{2} + 0.\frac{1}{2}\right] = 1.$$

136. A source produces three symbols A, B and C with probabilities P(A) $= \frac{1}{2}$, P(B) = $\frac{1}{4}$ and P(C) $= \frac{1}{4}$. The source entropy is

(A) $\frac{1}{2}$ bit / symbol

(B) 1 bit/symbol

(C) $1\frac{1}{4}$ bits / symbol

(D) $1\frac{1}{2}$ bits/symbol

Key:(D)

$$\text{Given } P(n) = \frac{1}{2}$$

$$P(B) = P(C) = \frac{1}{4}$$

$$\text{Entropy} = \sum_i P_i \log\frac{1}{P_i}$$

$$= \frac{1}{2} + \frac{1}{2} + \frac{1}{2}$$

$$= \frac{3}{2} = 1\frac{1}{2} \text{ bits / symbol}$$

137. An AM wave with modulation index 0.8 has total sideband power of 4.85kW. The carrier power and the total power radiated will be nearly

(A) 12.2 kW and 20kW

(B) 15.2kW and 20kW

(C) 12.2kW and 25kW

(D) 15.2kW and 25kW

Key:(B)

In AM wave have $\mu = 0.3$ total side bond power $P_c\frac{\mu^2}{2} = 4.85\text{ kW}$

We know that $P_T = P_C\left[1 + \frac{\mu^2}{2}\right]$

$$P_C = 15.156\text{ kW}$$

$$P_T = 15.156[1.32] = 20\text{ kW}$$

138. A 360W carrier is simultaneously modulated by two audio waves with modulation percentages of 55 and 65 respectively. The effective modulation index and the total power radiated are

(A) 0.85 and 490.5W

(B) 0.64 and 490.5W

(C) 0.85 and 450.5W

(D) 0.65 and 450.5W

Key:(A)

$$\mu = \sqrt{\mu_1^2 + \mu^2} = 0.85$$

$$P_T = P_c\left[1 + \frac{\mu^2}{2}\right] = 360[1 + 0.3625]$$

$$= 490.5\text{ W}$$

139. An amplitude modulated amplifier has a radio frequency output of 50W at 100% modulation. The internal loss in the modulator is 10W. The unmodulated carrier power is

(A) 40W

(B) 50W

(C) 60W

(D) 80W

Key:(A)

$$P_{in} = P_{out} + P_d$$

$$= 50 + 10 = 60\text{W}$$

140. For an FM receiver with an input signal-to-noise ratio of 29dB, a noise figure of 4 dB and an FM improvement factor of 16dB, the pre-detection and post-detection signal-to-noise ratios are

(A) 25 dB and 41 dB

(B) 30 dB and 49 dB

(C) 25 dB and 49 dB

(D) 30 dB and 41 dB

Key:(A)

We know that

$$[SNR]_{improvement} = \left[\frac{S}{N}\right]_{post-detection} - \left[\frac{S}{N}\right]_{pre-detection}$$

$$\left[\frac{S}{N}\right]_{input} = \left[\frac{S}{N}\right]_{Pre-detection} + F$$

$$\left[\frac{S}{N}\right]_{Pre-detection} = 29 - 4 = 25dB$$

$$\left[\frac{S}{N}\right]_{post-detection} = 16 + 25 = 41\,dB$$

141. For Gaussian and White channel noise, the capacity of a low – pass channel with a usable bandwidth of 3000 Hz and $\frac{S}{N} = 10^3$ at the channel output will be

(A) 15000 bits/s

(B) 20000 bits/s

(C) 25000 bits/s

(D) 30000 bits/s

Key:(D)

$$C = B\log_2\left[1 + \frac{S}{N}\right]$$

$$= 3000\log_2\left[1 + 10^3\right] = 30000\ bit/sec$$

142. For a PM modulator with a deviation sensitivity K = 2.5rad/V and a modulating signal $v_m(t) = 2\cos(2\pi 2000t)$, the peak phase deviation m will be

(A) 1.25rad

(B) 2.5rad

(C) 5.0rad

(D) 7.5rad

Key:(C)

$$\phi(t) = 2\pi f_c t + K_p A_m \cos(2\pi \times 2000t)$$

$$\phi_{max} = 2.5 \times 2 = 5$$

$$\phi_{min} = -2.5 \times 2 = -5$$

$$\Delta\phi = \frac{|5 - (-5)|}{2} = 5.0\ rad$$

143. In a PCM system, non-uniform quantization leads to

(A) increased quantize noise

(B) simplification of the quantization process

(C) higher average SNR

(D) increased bandwidth

Key: (C)

Advantages of Non- Uniform Quantization:

1. Higher average signal to quantization noise power ratio than the uniform quantizer when the signal pdf is non uniform which is the case in many practical situation.

2. RMS value of the quantizer noise power of a non – uniform quantizer is substantially proportional to the sampled value and hence the effect of the quantizer noise is reduced.

144. The bandwidth required in DPCM is less than that of PCM because

(A) the number of bits per code is reduced resulting in a reduced bit rate

(B) the difference signal is larger in amplitude than actual signal

(C) more quantization levels are needed

(D) the successive samples of signal often differ in amplitude

Key:(D)

145. For the given transfer function

$$G(s)=\frac{Y(s)}{R(s)}=\frac{1}{s^2+3s+2}$$

The response y(t) for a step input r(t) = 5u(t) will be

(A) $\left[\frac{5}{2}-5e^{-t}+\frac{5}{2}e^{-2t}\right]u(t)$

(B) $\left[\frac{5}{2}-5e^{-t}\right]u(t)$

(C) $\left[\frac{5}{2}+\frac{5}{2}e^{-2t}\right]u(t)$

(D) $\left[-5e^{-t}+\frac{5}{2}e^{-2t}\right]u(t)$

Where u(t) is a unit step input.

Key:(A)

$$\rightarrow G(s)=\frac{Y(s)}{R(s)}=\frac{1}{S^7+3S+2}$$

$$Y(s)=G(S)R(S)$$

$$=\frac{1}{(S+1)(S+2)}\left[\frac{5}{S}\right]\left[\begin{array}{l}\because \text{if } r(t)=5u(t)\\ R(S)=5/S\end{array}\right]$$

$$=\frac{5/2}{S}+\frac{-5}{S+1}+\frac{5/2}{S+2}$$

$$\Rightarrow y(t)=\left[\frac{5}{2}-5e^{-t}+\frac{5}{2}e^{-2t}\right]u(t)$$

146. The price for improvement in sensitivity by the use of feedback is paid in terms of

(A) loss of system gain

(B) rise of system gain

(C) improvement in transient response, delayed response

(D) poor transient response

Key:(B)

$\rightarrow$Closed loop transfer function $T=\frac{G}{1+GH}$

$$S_G^T=\frac{G}{T}\frac{\partial T}{\partial G}=\frac{1}{1+GH}$$

$$S_H^T=\frac{H}{T}\frac{\partial T}{\partial H}=\frac{-GH}{1+GH}$$

$$\left|S_H^T\right|>\left|S_G^T\right|$$

So we can say improvement in sensitivity due to use of feedback [H] results increase in system gain.

147. Consider a feedback system with the characteristic equation

$$1+K\frac{1}{s(s+1)(s+2)}=0$$

The asymptotes of the three branches of root locus plot of this system will form the following angles with the real axis

(A) 60°, 120° and 300°

(B) 60°, 120° and 180°

(C) 60°, 180° and 300°

(D) 40°, 120° and 200°

Key:(C)

$\rightarrow$ Angle of asymptote, $\phi=\frac{(2K+1)180°}{P-z}$

$$\phi=\frac{(2K+1)180°}{3}\quad (k=0,1.......(p-z)-1)$$

$$=(2K+1)60°\,(K=0,1,2)$$

$$\phi_1=60°(\text{when } K=0)$$

$$\phi_2=180°(\text{When } K=1)$$

$$\phi_3=300°(\text{When } K=2)$$

148. If the characteristic equation of a feedback control system is given by $s^4 + 20s^3 + 15s^2 + 2s + K = 0$ then the range of values of K for the system to be stable will be

(A) $1 < K < 2.49$

(B) $0 < K < 1.49$

(C) $1 < K < 4.49$

(D) $0 < K < 3.49$

Key:(B)

$\rightarrow$ The characteristic equation B given as

$$S^4 + 20s^3 + 15s^2 + 2s + K = 0$$

Forming the R-H table

S^4	1	15	K
S^3	20	2	
S^2	$\frac{300-2}{20}$	K	
S^1	$\frac{2\left(\frac{298}{20}\right)-20k}{\left(\frac{298}{20}\right)}$		
S^0	K		

For stability $K > 0$

$$2\left(\frac{298}{20}\right) - 20K > 0 \Rightarrow K < 1.49$$

So the stability range is $0 < K < 1.49$

149. For Type- 2 system, the steady state errors for unit step and unit ramp input are

(A) 0 and ∞

(B) ∞ and 0

(C) 0 and 0

(D) ∞ and ∞

Key:(C)

For a type 2 system

e_{ss} for step input is 0

e_{ss} for ramp input is 0

$$ess/_{slep} = \frac{1}{1+K_p} = \frac{1}{1+\ell t_{s\to 0} G(s)}$$

$$= \frac{1}{1+\ell t_{s\to 0} \frac{K}{s^2(s+2)}} = \frac{1}{1+\infty} = 0$$

$$ess/_{ramp} = \frac{1}{K_v} = \frac{1}{\ell t_{s\to 0} sG(s)} = \frac{1}{\ell t_{s\to 0} s \frac{K}{s^2(s+2)}} = \frac{1}{\infty} = 0$$

150. Consider the following statements regarding a parabolic function:

1. A parabolic function is one degree faster than the ramp function.

2. A unit parabolic function is defined as

$$f(t) = \begin{cases} \frac{t^2}{2}, & \text{for } t > 0 \\ 0, & \text{otherwise} \end{cases}$$

3. Laplace transform of unit parabolic function is $\frac{1}{s^3}$.

Which of the above statements are correct?

(A) 1 and 2 only

(B) 1 and 3 only

(C) 2 and 3 only

(D) 1, 2 and 3

Key:(D)

$$\rightarrow P(t) = \frac{t^2}{2}u(t); \quad p(s) = \frac{1}{S^3}$$

$$\rightarrow r(t) = tu(t); R(s) = \frac{1}{S^2}$$

By comparing P(s) & R(s) we can say P(s) having one pole more compared to R(S), so parabolic function is one degree faster than ramp function

Standard defilation of unity parabolic function

$$P(t) = \frac{t^2}{2}u(t); \; P(s) = 1/s^3$$